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## Science Topics: Particulate Matter: Background

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### Why is NCER performing PM research?

Particulate matter (PM) has been linked to a range of serious respiratory and cardiovascular health problems. The key effects associated with exposure to ambient particulate matter include: premature mortality, aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits, school absences, work loss days, and restricted activity days), aggravated asthma, acute respiratory symptoms, chronic bronchitis, decreased lung function, and increased risk of myocardial infarction. Recent epidemiologic studies estimate that exposures to PM may result in tens of thousands of excess deaths per year, and many more cases of illness among the US population.

NCER's extramural PM research is designed to assist in solving many uncertainties about the impacts of PM exposure on mortality and illness. NCER has been conducting PM research indirectly through our Air Toxics solicitations since 1995 and



In fiscal year 1998 Congress urged EPA to establish as many as five university-based research centers focused on PM research. Congress also asked EPA to arrange for an independent study by the National Academy of Sciences, National Research Council (NRC), to develop priorities for a comprehensive PM research plan, develop a near and long-term PM research program, and to monitor research progress over the next five years. On March 31, 1998, the NRC released its first report entitled *Research Priorities for Airborne Particulate Matter: 1. Immediate Priorities and Long-Range Research Portfolio*. Based on recommendations from this NRC report and earlier strategic assessments, ORD is developing and implementing an

directly with solicitations dedicated to PM topics since 1998. In 1999 NCER funded 5 PM Centers through a competitive solicitation. These efforts were designed to support the priorities identified by the National Research Council and assist the Office of Air in the review and revision of the PM National Ambient Air Quality Standard.

ORD and EPA Program Offices are also conducting PM research that support the NRC PM research priorities and the establishment of air quality standards and the implementation of strategies to reduce PM-related health risks. The ORD research program also includes: risk assessment activities to periodically review and update the PM Air Quality Criteria Document; and, risk management research support the implementation of air quality standards by state and local governments.

[View summaries and links to related ORD PM research activities.](#)

[View summaries and links to related EPA PM research activities.](#)

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#### **What are our goals?**

NCER's goals are to support a peer reviewed research program that provides good scientific information across the range of PM health research priority topics identified by the National Research Council, and supports the review and revision of the PM National Ambient Air Quality Standards (NAAQS).

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#### **Characterization of Airborne PM**

PM represents a broad class of chemically and physically diverse substances. Particles can be described by size, formation mechanism, origin, chemical composition, atmospheric behavior and method of measurement. The concentration

integrated research program for PM which includes in-house studies, interagency research, and RFAs through which scientists may compete for grant awards.

See [Research Priorities for Airborne Particulate Matter](#)

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for more details about the NRC's recommendations.

#### **PM Research Priorities identified by the National Research Council:**

1. Outdoor Measures vs. Actual Human Exposures: What are the relationships between concentrations of PM and gaseous copollutants measured at stationary outdoor air monitoring sites and what are the contributions of these concentrations to actual personal exposures?
2. Exposures of Susceptible Subpopulations to Toxic PM components: What are the exposures to the most biologically important constituents of PM that cause responses in potentially susceptible subpopulations and the general population?
3. Characterization of Emission Sources: What are the size-distribution, chemical-composition, and mass-emission rates of PM emitted from primary-particle sources in the U.S., and what are the emissions of the reactive gases that lead to secondary particle formation through atmospheric chemical reactions?
4. Air Quality Modeling and Testing: What are the linkages between emission sources and ambient concentrations of the biologically important

of particles in the air varies across space and time, and is related to the source of the particles and the transformations that occur in the atmosphere.

PM can be principally characterized as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions:

- \* PM10 (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung);
- \* PM2.5, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less)
- \* PM10-2.5, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and
- \* Ultrafine particles generally defined as those less than 0.1 microns.

Fine and coarse particles are distinct in terms of the emission sources, formation processes, chemical composition, atmospheric residence times, transport distances and other parameters. Fine particles are directly emitted from combustion sources and are also formed secondarily from gaseous precursors such as sulfur dioxide, nitrogen oxides, or organic compounds. Fine particles are generally composed of sulfate, nitrate, chloride and ammonium compounds, organic and elemental carbon, and metals. Combustion of coal, oil, diesel, gasoline, and wood, as well as high temperature process sources such as smelters and steel mills, produce emissions that contribute to fine particle formation. Fine particles can remain in the atmosphere for days to weeks and travel through the atmosphere hundreds to thousands of kilometers, while most coarse particles typically deposit to the earth within minutes to hours and within tens of kilometers from the

components of PM?

5. Assessment of Hazardous PM Components: What is the role of biological, chemical, and physical characteristics of PM in eliciting adverse health effects?
6. Dosimetry-Deposition of PM in the Respiratory Tract: What are the deposition patterns and fate of particles in the respiratory tract of individuals belonging to presumed susceptible subpopulations?
7. Combined Effects of PM and Gaseous Copollutants: How can the effects of PM be disentangled from the effects of other pollutants? How can the effect of long-term exposures to PM and other pollutants be better understood?
8. Susceptible Subpopulations: What subpopulations are at increased risk of adverse health outcomes from PM?
9. Mechanism of Injury: What are the underlying mechanisms that can explain the epidemiological findings of mortality and morbidity associated with exposure to PM?
10. Analysis and Measurement: To what extent does the choice of statistical models in the analysis of data from epidemiologic studies influence estimates of health risks from PM? Can existing methods be improved? What is the effect of measurement error and misclassification on the estimates of the association between air pollution and health?

emission source. Some scientists have postulated that ultrafine particles, by virtue of their small size and large surface area to mass ratio may be especially toxic. There are studies which suggest that these particles may leave the lung and travel through the blood to other organs, including the heart. Coarse particles are typically mechanically generated by crushing or grinding and are often dominated by resuspended dusts and crustal material from paved or unpaved roads or from construction, farming, and mining activities.

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**NCER's PM Research is being performed under:**

- GPRA Goal 1- Clean Air
- Objective 1- Attain NAAQS for Tropospheric Ozone and Particulate Matter
- Sub-objective 005: Particulate matter health risk model
  - Provide new information on the atmospheric concentrations, human exposure, health effects and mechanisms of toxicity of particulate matter, and facilitate PM NAAQS review through Air Quality Criteria Document development and consultation. Provide data on health effects and exposure to PM and provide methods for assessing the exposure and toxicity of PM in healthy and potentially susceptible populations to strengthen the scientific basis for reassessment of the NAAQS for PM.
- (NRC Topics 5, 8 and 9)

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### **Particulate Matter (PM) Health Effects**

#### **Research Centers Program - Research Highlights**

Numerous epidemiological studies have reported associations between ambient air particulate matter (PM) concentrations and a variety of health outcomes, including increased mortality, hospital admissions, emergency room and clinician visits, medication usage, and lost-time from work and school. The consistency of these findings was remarkable, considering the diverse study populations, meteorological conditions, air quality characteristics, and the variety of study designs.

Questions concerning the validity of epidemiological results focused on the use of ambient PM concentrations as population exposure surrogates and the potential



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confounding effects of gaseous co-pollutants. Both of these questions have now been effectively addressed, in part, by the PM Centers Program. Concerns over biological plausibility were raised due to the incomplete state of knowledge regarding: 1) appropriate human and animal models which produce biological responses at levels comparable to those reported in the epidemiological studies; 2) techniques to expose subjects to concentrated ambient particles (CAPs), or laboratory generated surrogates that focus on specific particle characteristics such as size and/or chemistry; 3) information concerning the physical and chemical properties of PM that are responsible for the reported adverse health effects and; 4) the potentially additive or synergistic effect of gaseous co-pollutant exposures on acute and chronic effects.

To address these scientific concerns, Congress directed the EPA, in 1996, to substantially increase its level of funding on PM health effects research. It also mandated that a National Research Council (NRC) Committee (i.e., the Committee on Research Priorities for Airborne Particulate Matter) be established to provide scientific oversight for the PM research. In the first of its three reports, the NRC Committee recommended a multi-year research program that included the establishment of academically-based research Centers to create a comprehensive and integrated PM health effects research program. The PM Centers were needed to foster interdisciplinary collaborations within and among institutions. Research that arose through these collaborations was, in turn, intended to help EPA address scientific issues about PM health effects in a timely and effective manner.

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Excerpts from *The EPA's Particulate Matter (PM) Health Effects Research Centers Program: A Mid-Course (2 1/2 year) Report of Status, Progress, and Plans, prepared by the Directors and Senior Associates of the PM Centers , January 8, 2002* and may not represent the views or policies of EPA or ORD.

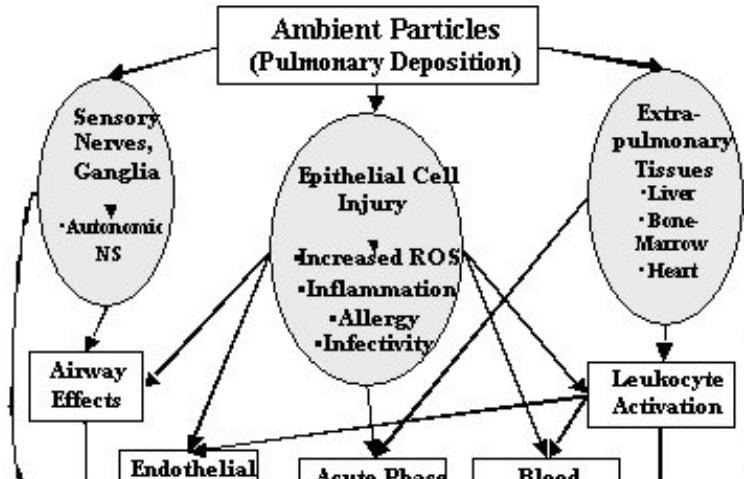
The perspectives, information and conclusions conveyed in research project abstracts, progress reports, final reports, journal abstracts and journal publications convey the viewpoints of the principal investigator and may not represent the views and policies of ORD and EPA. Conclusions drawn by the principal investigators have not been reviewed by the Agency.

## BIOLOGICAL MECHANISMS FOR PM HEALTH EFFECTS

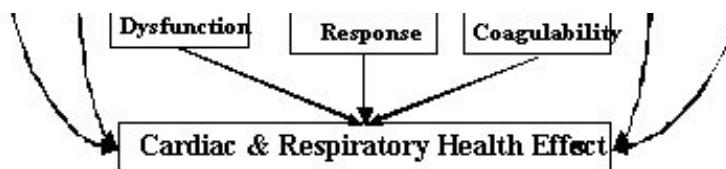
### Background

The justifications for the 1997 PM<sub>10</sub> and PM<sub>2.5</sub> NAAQS were primarily based on a large and coherent epidemiological data base of significant associations between ambient air PM concentrations and excess mortality and morbidity. Although the 1996 PM Criteria Document provided some support for biological plausibility of causal links between PM and health effects, evidence from controlled human and animal exposure studies was still largely unavailable. Based on this information gap, a major rationale for the establishment of the PM Centers was to explore biological plausibility and mechanisms of PM-associated health outcomes. Over the past two years, substantial contributions have been made toward developing hypotheses based on experimental observations – in large part because of the research environment fostered by the PM Centers' structure. The following section provides examples of how the PM Centers program has contributed to the development and testing of plausible mechanistic hypotheses for the health effects of PM.

**Figure 1: Hypotheses for Health Effects of PM**



Recently, several mechanistic pathways have been investigated that may link PM exposure with adverse health effects. Figure 1 highlights the complexity and interdependency of some of these pathways (Utell and Frampton, 2000). The portal of entry for PM air pollution is the lung, and PM interactions with respiratory epithelium likely mediate a wide range of effects, as indicated by the central oval in Figure 1. These include respiratory as well as systemic and cardiovascular effects. However, PM, or its reaction products, may stimulate airway sensory nerves, leading to changes in lung function and in autonomic tone, which influences cardiac function. Ultrafine particles, by virtue of their extremely small size, may enter pulmonary capillary blood and be rapidly transported to extrapulmonary tissues, such as liver, bone marrow, and heart, with either direct or indirect effects on organ function.



## Progress Made

This section discusses mechanistic areas in which particular progress has been made by the PM Centers such as: 1) inflammation and immunity; 2) mechanisms for cardiovascular effects; and 3) the role of reactive oxygen species (ROS).

### Inflammation and Immunity

Airway injury and inflammation is a well known consequence of toxic inhalation exposures. Previous studies involving animal models have shown that instillation or inhalation of particles, such as diesel exhaust particles (DEP), can cause inflammation and epithelial injury at high doses and concentrations. However, there was little evidence, prior to the PM Centers Program, that exposure to ambient concentrations of PM caused significant airway inflammation. The presence or absence of an inflammatory response is an important issue, because inflammation may induce systemic effects, including an acute phase response with increased blood viscosity and coagulability, and possibly an increased risk for myocardial infarction in patients with severe coronary artery disease. In chronic respiratory diseases, such as asthma and COPD, inflammation is a key pathophysiologic feature. Chronic, repeated inflammatory challenge of the airways, may result in airway remodeling that leads to irreversible lung disease. Thus, inflammation may be involved in both acute and chronic effects.

Listed below are several key findings from PM Center research about the role of inflammation and immunity in mediating the health effects of PM.

**PM Exposure and Systemic Markers of Inflammation in Humans:** The PM Centers in Southern California and Rochester have collaborated in human clinical studies, using identical crossover exposure protocols, subject recruitment criteria, and outcome measures. The California studies used concentrated ambient air particles (CAPs) at approximately 200 µg/m<sup>3</sup>, and Rochester used laboratory-generated carbonaceous ultrafine particles at two concentrations, 10 and 25 µg/m<sup>3</sup>. Preliminary findings from both of these studies provide evidence for effects on systemic markers of inflammation and leukocyte recruitment (Frampton et al., 2001; Daigle et al., submitted; Boscia et al., 2000).

In both Centers, subjects were exposed for two hours with intermittent exercise. Before and at intervals after exposure, symptom ratings, lung function testing, and phlebotomy were performed. Sputum induction was performed approximately 24 hours after exposure. In both Centers, blood was analyzed for markers of systemic inflammation, acute phase response, and blood coagulability. One such marker is soluble intercellular adhesion molecule-1 (sICAM-1), a transmembrane protein that is expressed on leukocytes and endothelial cells. sICAM-1 plays an important role in monocyte recruitment to atherosclerotic lesions and inflamed airways, where it is shed into plasma during leukocyte adhesion.

In the Southern California CAPs studies, sICAM-1 increased progressively in both healthy and asthmatic subjects ( $p=0.045$ ), with the largest increase observed at 21 hours after exposure. In the Rochester ultrafine particle studies, there was no significant change in sICAM-1 in the plasma of healthy subjects, but blood monocyte expression of ICAM-1 decreased immediately following particle exposure in a concentration-response fashion compared with air exposure (See Figure 2), and the number of circulating monocytes decreased at 21 hours after exposure. These studies suggest that exposures to either CAPs or ultrafine particles may initiate endothelial and leukocyte activation, with shedding of surface ICAM-1, a key initial step in leukocyte recruitment. These findings may have implications for cardiovascular and respiratory disease. In a major cardiac epidemiological study, plasma sICAM-1 levels were predictive of future coronary events (Ridker et al., 1998).

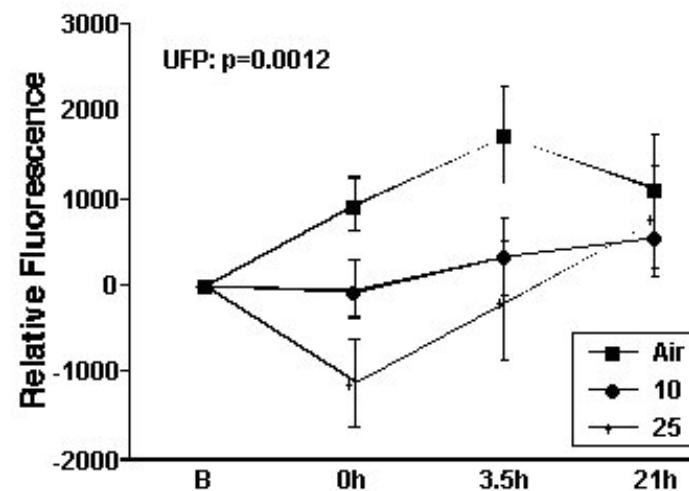


Figure 2. Blood monocyte expression of intercellular adhesion molecule-1 (ICAM-1, CD54) after air and UFP exposure (10 and 25  $\mu\text{g}/\text{m}^3$ ). Data are mean  $\pm$  SE change from pre-exposure baseline.

**PM Exposure and Inflammation in Animals:** Studies in normal dogs exposed to Boston CAPs by inhalation showed increases in pulmonary inflammation by broncho-alveolar lavage and in circulating blood neutrophils associated with increases in specific ambient particle components. In these experiments, mean exposure doses were 203.4 and 360.8  $\mu\text{g}/\text{m}^3$  in the lavage and blood studies, respectively (Clarke et al., 2000). These PM Center studies show that ambient particle components have significant pulmonary and systemic inflammatory potential.

**Effects of Aging:** Determining the mechanisms involved in increased susceptibility to PM comprises another goal of PM Center research which is being explored at many levels. The role of aging is being examined, using animal and human exposure studies as well as *in vitro* models. Recently, *in vitro* models have provided important new insights into the role of aging at the cellular level in determining PM responses. Studies were conducted examining cytokine production by alveolar macrophages from aged rats and mice (>20 months old), after *in vitro* exposure to lipopolysaccharide (LPS) and PM. Macrophages isolated from aged animals were incubated with endotoxin, with laboratory-generated mixed carbon/iron ultrafine particles, or with both LPS and ultrafine particles. Baseline production of cytokines was elevated 30-50% in aged cells compared to cells from young (8-10 weeks) animals. The response to LPS was enhanced at every dose in aged cells. The response to ultrafine particles containing iron was enhanced 2-3 fold in aged cells compared to young cells. Most significantly, in the aged animals co-administration of ultrafine particles and LPS led to synergistic effects at the lowest ultrafine particle dose, while in young cells this was observed only at the highest PM dose (Finkelstein et al., submitted). These findings suggest that there is a cellular basis for age-related increased susceptibility that may relate to increased susceptibility to oxidative stress. Alternatively, the results may be showing a lower threshold due to impaired protective mechanisms (e.g., antioxidant defenses). Investigations of these age-related differences are currently focusing on signal transduction mechanisms.

**Effects on Infection/Pneumonia:** Epidemiological studies have demonstrated that infection, specifically pneumonia, contributes substantially to the increased morbidity and mortality among elderly individuals following exposure to PM (Shwartz, 1994), suggesting that inhaled PM can act as an immunosuppressive factor that undermines normal host pulmonary immune responses. A combination of particle concentrator technology and animal infectivity models is being used to investigate this hypothesis. A single 5 hour inhalation exposure of bacterially-infected rats to New York City (NYC) CAPs, at concentrations ranging from 65 to 150  $\mu\text{g}/\text{m}^3$ , altered both pulmonary and systemic immunity, and exacerbated the infection process in a

time-dependent manner (Zelikoff et al., 1999). *Streptococcus pneumoniae*-infected rats exposed to PM demonstrated increased burdens of pulmonary bacteria, numbers of circulating white blood cells, extent of pneumococcal-associated lung lesions, and incidence of bacteremia, compared to air-exposed, infected control rats. Conversely, this same PM exposure resulted in decreased levels of lavageable polymorphonuclear neutrophils (PMN), bronchus-associated lymphoid tissue, and proinflammatory cytokines (i.e., tumor necrosis factor-a, interleukin-1, and interleukin-6) in infected rats. Subsequent studies implicated the iron content of NYC PM in mediating these effects; many of the findings were reproduced with nose-only exposure to soluble iron, but not with soluble forms of other metals (manganese, copper, or nickel). These findings suggest that PM exposure, and specifically the soluble iron component, may affect the host immune response during pulmonary infection, and may help to explain epidemiological observations. In addition to the effects of iron, PM Center investigators have shown that Diesel engine exhaust particles (DEP) and CAPs induce apoptosis in macrophages by an oxidative stress mechanism that is dependent on the organic chemicals in the PM. Macrophage apoptosis will lead to decreased phagocytic defenses in the lung.

### **Cardiovascular Effects**

Determining the mechanisms linking ambient PM to cardiovascular effects is one of the key challenges of the PM Centers. There is growing clinical and epidemiological evidence that ambient air pollution can precipitate acute cardiac events, such as angina pectoris, cardiac arrhythmias, and myocardial infarction, with the majority of excess PM-related deaths attributable to cardiovascular disease. The PM Centers approach to this issue is multifaceted and multidisciplinary. There are ongoing panel studies of susceptible subjects involving cardiovascular monitoring at three PM Centers, animal exposure studies at four PM Centers, and human clinical studies at three PM Centers. For example, three PM Centers share a cardiac monitoring and analysis protocol for human clinical studies.

A major step forward in this area was made with the convening of a workshop "Cardiovascular Effects of Air Pollution: Potential Mechanisms and Methods of Testing", which met in Rochester in March, 2001. The Workshop featured presentations by PM Center and other investigators, along with clinical and research cardiologists. Each of the five EPA-supported PM Centers participated in the Workshop along with representatives from EPA. New hypotheses and research directions were developed, and practical issues of cardiac monitoring methodology currently in use at each PM Center were reviewed and optimized. This Workshop grew directly from one of the annual PM Center Directors meetings, where the need for inter-center collaboration on this issue was identified. The interchange of ideas served as an important turning point in our thinking about the mechanisms involved in cardiac effects, and new collaborative efforts were initiated. This would not have happened without the PM Center structure.

Key observations in both human and animal studies of cardiovascular effects have been made since the PM Center Program was initiated. A few examples follow.

**Human Studies:** Investigation of cardiovascular effects of PM has required multidisciplinary collaboration. For human exposure studies, analysis of cardiac monitoring includes a detailed analysis of heart rate variability (HRV) and repolarization intervals before, during, and for a period of 48 hours after exposure. In one study, healthy subjects were exposed by mouthpiece for two hours with intermittent exercise on three separate occasions to air or ultrafine carbon particles at 10 and 25  $\mu\text{g}/\text{m}^3$ . Frequency-domain analysis of the continuously recorded electrocardiogram indicated that response of the parasympathetic nervous system was blunted during recovery from exercise immediately after exposure to ultrafine particles, compared with air. This diminished vagal response was not observed 3.5 hours later. Monitoring also indicated that exposure to ultrafine particles altered cardiac repolarization, as indicated by the corrected QT interval (QTc) on the cardiogram. Figure 3 shows the change in QTc from the pre-exposure baseline. The increase in QTc following exercise during air exposure was blunted with PM exposure, and this persisted to at least 21 hours after exposure. This change in repolarization was not explained by changes in heart rate (Frampton, 2001; Zareba et al., 2001). It is plausible that ultrafine particle exposure imposes an effect on repolarization, either through an indirect effect via the autonomic nervous system, or by directly affecting ion

channel function in ventricular myocardium through a yet unknown mechanism. This observation is important, because changes in the QT interval have been implicated in susceptibility to cardiac arrhythmias in patients with heart disease.

These human clinical studies are complemented by a major panel study involving patients with pre-existing coronary artery disease in Erfurt, Germany. Analysis of the electrocardiogram (EKG) recordings and blood parameters are underway, including detailed analyses of heart rate variability and repolarization, and acute phase proteins using methodology identical to the human clinical studies. These clinical/epidemiological/toxicological collaborations are an example of how the PM Centers Program has fostered research among diverse disciplines and locales.

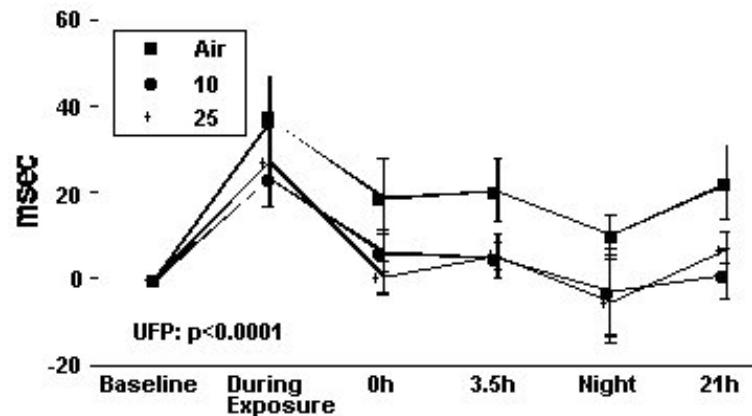


Figure 3. Cardiac repolarization duration using Bazett's correction for heart rate (QTc interval), after air and UFP exposure (10 and 25  $\mu\text{g}/\text{m}^3$ ). Data are mean  $\pm$  SE change from pre-exposure baseline.

**Animal Studies:** Rats and mice are being instrumented for continuous cardiac and blood pressure monitoring. Algorithms have been developed for analysis of heart rate and blood pressure variability using continuous 24-hour recordings in up to 8 rodents simultaneously (Couderc et al., submitted). Presently, a crossover study with aging, spontaneously hypertensive rats exposed to carbonaceous ultrafine particles is ongoing.

PM Center investigators are evaluating both inflammation and cardiovascular effects in animal models. The hypothesis being tested is that inhaled PM causes release of inflammatory mediators from cells in the lung that then become blood borne and target the cardiovascular system. The research plan uses transgenic mouse strains with specific cardiovascular genetic alterations in order to create susceptibility models. Initial studies have been using a mouse model of atherosclerosis, the apolipoprotein E-deficient mouse generated via a targeted disruption of the mouse apo-E gene. The deficiency of apo-E leads to a spontaneous hypercholesterolemia. The nonhypertensive animals form atherosclerotic lesions throughout the vasculature which resemble, in part, human atherosclerotic lesions at 3 to 5 months of age. Animals are instrumented and monitored for blood pressure and heart rate using radiotelemetry. Individual mice were dosed with 125  $\mu\text{g}$  of Washington, DC urban dust in 50  $\mu\text{l}$  saline by oropharyngeal aspiration into the lungs. Heart rate was reduced after exposure to PM in normal and in apoE-/ mice. ApoE-/ mice showed a trend to increased blood pressure and increased variability of blood pressure after PM exposure that did not differ significantly from that of the normal mice (Luchtel et al., 2002). Additional experiments are being performed as the control and apoE-/ mice age, and studies involving more realistic exposures are being planned.

In another PM Center study, 18 month old male Fischer 344 rats with implanted EKG transmitters were used to determine the effects of PM on the frequency of spontaneous arrhythmias. Since old rats were found to have many spontaneous arrhythmias, a standardized definition for each type of arrhythmia was developed and a procedure for quantifying the frequency of

spontaneous arrhythmias was established. Rats were exposed to New York City CAPs or filtered air for 4 hours. The rats were exposed twice with a crossover design so each rat could serve as its own control. The CAP concentration was 160  $\mu\text{g}/\text{m}^3$  and 200  $\mu\text{g}/\text{m}^3$  for the first and second exposures, respectively. EKG tracings demonstrated a significant increase in the frequency of supraventricular arrhythmias following exposure to CAPs compared to filtered air-exposed control animals. The same rats were also exposed twice to 1 ppm SO<sub>2</sub> and twice to air in a repeated crossover design. No significant change in the frequency of any category of spontaneous arrhythmia following exposure to SO<sub>2</sub> (or filtered air) was observed (Nadziejko et al., 2002).

The effects of PM on myocardial ischemia has also been the focus of PM Center research. The extent to which inhaled PM exacerbates ischemia in a clinically relevant model of coronary artery occlusion in conscious dogs has been quantified. For the ischemia studies, dogs undergo thoracotomy for implantation of a vascular occluder around the left anterior descending coronary artery and tracheostomy to facilitate particulate exposure. After recovery, pairs of dogs are exposed by inhalation for 6 hr/day on 4 consecutive days. Immediately following each exposure, each dog undergoes a 5-min preconditioning coronary artery occlusion followed 20 min later by the 5-min experimental study coronary artery occlusion. Peak ST-segment elevation, heart rate, and arrhythmia incidence during occlusion are determined from continuous EKG recordings. Exposure to CAPs increased peak ST-segment elevation during a 5-min coronary artery occlusion (Figure 4). Neither heart rate nor arrhythmia incidence was affected by CAPs exposure. The finding that PM exacerbates acute myocardial ischemia suggests that vascular responses and pathophysiological events leading to changes in vessels may be key mechanisms by which PM may trigger acute cardiac events (Wellenius et al., submitted). PM Center research has also studied the effects of combinations of CAPs and CO in the rat model of myocardial infarction. In other studies of the vascular response to inhaled particles, a variety of cell and molecular biologic methods have been used.

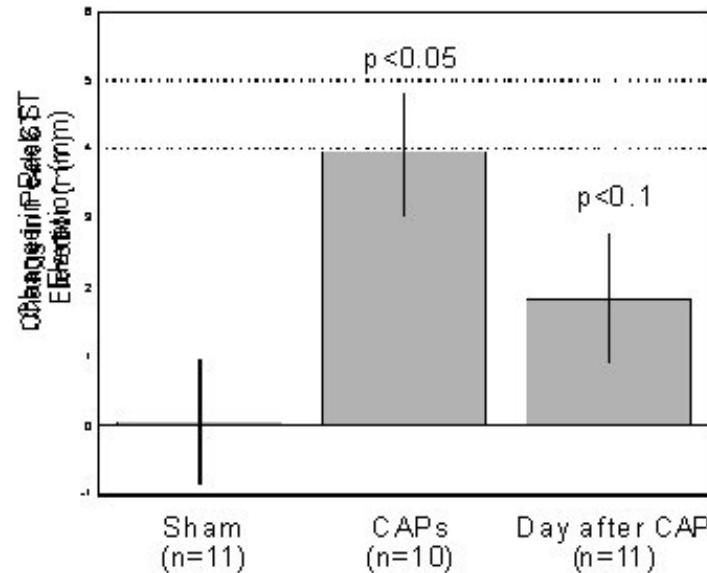


Figure 4. Changes in peak ST-segment elevation in canine acute myocardial ischemia studies following CAPs or sham.

### **Reactive Oxygen Species (ROS)**

It is likely that more than one biological mechanism is involved in the health effects of PM. However, a major finding has been that PM generate ROS, which provide pro-inflammatory stimuli to bronchial epithelial cells and macrophages. These cellular targets respond with cytokine and chemokine production, which can enhance the response to allergens. PM may therefore act as an adjuvant that strengthens the response of the immune system to environmental allergens. Hallmarks of allergic inflammation include increased immunoglobulin E (IgE) production, eosinophilic bronchial inflammation, airway

hyperresponsiveness, and an increase of NO in exhaled air.

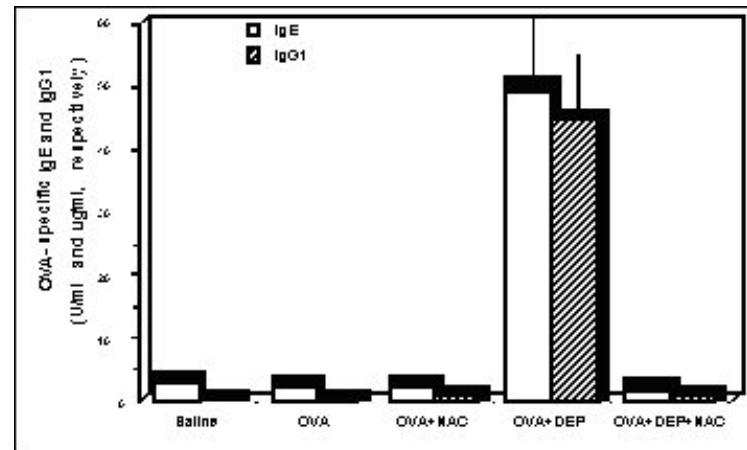


Figure 5. Thiol antioxidant interferes in the adjuvant effects of DEP during ovalbumin sensitization in a murine allergic inflammation model.

This hypothesis is being tested using *in vitro* and animal studies (Ning et al., 2002; Whitekus et al., 2002). In one study using an allergic mouse model, animals were exposed at high doses to nebulized DEP ( $2000 \text{ mg/m}^3$ ) for 1 hour, followed by nebulized antigen (ovalbumin, OVA) for 20 minutes, daily for 10 days. A control group received saline instead of DEP followed by OVA. To determine the role of reactive oxygen species, the same exposure groups were pretreated every day with intraperitoneal N-acetyl cysteine (NAC) (320 mg/kg). Control animals received saline intraperitoneally. Two days after the last exposure, blood was obtained and assayed for IgE and IgG1, and the lungs were assayed for carbonyl proteins and lipid peroxides. DEP markedly enhanced the antibody response (Figure 5) and lipid peroxidation, and these effects were abrogated by antioxidant treatment. Follow-up studies using more realistic exposure levels of DEP and/or CAPs are being planned. Furthermore, human nasal challenge studies confirmed the role of DEP as an adjuvant in already established allergic responses, as well as in exposure to neo-allergens. Taken together, these findings may explain the increased number and severity of asthma attacks in an urban setting after a surge in PM levels, and may implicate DEP as a factor in asthma exacerbations.

Reactive oxygen species associated with exposure to PM may play a role in cardiovascular effects. 9,10-Phenanthroquinone (9,10-PQ) is a potent inhibitor of neuronal form of nitric oxide synthase (NOS). 9,10-PQ also inhibits the endothelial form of NOS which plays a critical role in vascular tone, thereby causing the suppression of NO-dependent vasorelaxation of aorta and significant increase in blood pressure in rats. Therefore, quinones and other compounds producing ROS, e.g., nitro-PAHs may contribute to diseases related to vascular dysfunction caused by exposure to urban air particles. In addition to the production of ROS, quinones, PAHs, nitro-PAHs, and related compounds may also undergo electrophilic addition to macromolecules producing complementary toxicity.

The key role of the PM Centers in facilitating this line of investigation on ROS has been the collaboration between scientists with expertise in particle physics (e.g., particle concentrators), animal asthma models, the cellular biology of oxidative stress and inflammation, and inhalation toxicology. For example, the collective expertise in the Southern California PM center facilitated the use of CAPs to replace DEP for mechanistic *in vitro* and *in vivo* studies. Asthma animal models are now being used to compare the pro-oxidative and pro-inflammatory effects of CAPs collected on California freeways and various source-receptor sites. In addition, human panel studies and CAPs exposure studies now typically include the role of oxidative stress in airway inflammation (e.g., assays for NO and CO content in the expired air, and measures of cytokines in induced sputum, blood, and breath condensate).

Another important development by the PM Centers is collaboration between organic/analytical chemists, particle engineers and biologists in exploring how chemicals constituents of CAPs contribute to ROS generation and inflammation. An important observation has been that organic components present in the organic carbon fraction generate ROS through their ability to undergo redox cycling. The *in vitro* reactions correlate well with the ability of organic PM components to generate oxidative stress in epithelial cells and macrophages. Preliminary evidence indicates that polycyclic aromatic hydrocarbons and their oxidized derivatives (quinones and ketones) play a key role in ROS generation at the cellular level. The *in vitro* toxicity studies predict a hierarchical or stratified oxidative stress response, in which the biological effects range from: (a) protective (e.g., expression of anti-oxidant enzymes) — (b) pro-inflammatory (e.g., production of cytokines and chemokines) — (c) cytotoxic (e.g., cellular apoptosis and necrosis), depending on the level of oxidative stress. The ability to relate the inherent redox-cycling and oxidative stress capabilities of a PM sample to specific biological effects allows a more rational interpretation of the *in vivo* toxicity data being generated in the community, freeway and source/receptor studies.

### **Short-Term PM Research Goals**

Objectives of the PM Centers during the remaining funding period will include a greater utilization of inter-Center collaborations. In addition to the collaborative efforts described in this section, new interactive Center initiatives will elucidate mechanisms of PM effects. These may also include sharing of PM collected from various sources at different PM Centers for use in animal and *in vitro* studies, sharing of exposure technology, and developing common laboratory protocols.

It is likely there are major, as yet undetermined pathways leading to PM effects, and an important objective will be to identify additional mechanistic links. For example, neural pathways may play a role in mediating cardiovascular effects. If studies that are currently underway confirm that there are major PM effects on autonomic regulation of cardiovascular function, we will need to further define the mechanisms by which those effects are initiated, including the cells and cell mediators responsible. Research on these mechanisms will provide vital clues about individual susceptibility and potential approaches to the prevention of adverse health effects.

Animal studies based on the hierarchical or stratified oxidative stress model are being planned. The application of the oxidative stress model will also consider the possible identification of susceptible human subjects with weakened oxidative stress defenses. This could involve polymorphisms of the heme oxygenase 1 gene, which is a very sensitive antioxidant defense mechanism that protects cells against redox-cycling DEP chemicals and contributes to CO and NO production during *in vivo* DEP exposure. The elucidation of susceptible individuals who can be studied with rational endpoints will enhance epidemiological studies and will also help to monitor the impact of regulatory measures to reduce adverse health effects.

A continuing research objective is to further examine the role of PM composition, size, surface area, gaseous co-pollutants and other factors in mediating effects. This involves a variety of experimental approaches, from detailed morphologic and chemical analysis of ambient air PM to *in vivo* and *in vitro* exposure studies using both CAPs and laboratory-generated PM of carefully defined composition. A related longer term goal is to determine the role of complex mixtures in eliciting health effects using factor analysis to identify the sources of PM and associated gaseous air pollutants.

Determining the mechanisms underlying individual susceptibility to PM effects is another major objective underway in each of the PM Centers. Host susceptibility factors being investigated include age, gender, underlying disease, infections, and genetic factors.

A key goal of PM Centers research is to develop biologic markers of specific mechanistic pathways that can be used to link findings from animal, human, and epidemiological studies. There are many examples that are currently being investigated, including plasma sICAM-1 and monocyte ICAM-1 as indicators of enhanced leukocyte endothelial interaction, and measurement of changes in heart rate variability as a measure of cardiovascular autonomic effects.

## Long-Term PM Research Goals

One major long-term objective of the PM Centers is to determine the mechanisms involved in the chronic health effects of ambient PM exposure. Epidemiological studies have indicated that exposure to PM<sub>2.5</sub> leads to a shortening of life span, and this finding was a major impetus in the establishment of the annual average PM<sub>2.5</sub> NAAQS. Does PM<sub>2.5</sub> exposure exacerbate underlying disease, or contribute to the genesis of disease (or both)? Some of the key findings currently being investigated in the PM Centers, and summarized here, have implications for chronic (long-term) effects.

For example, one hypothesis is that recurrent inflammatory or allergic challenges to the airway leads to airway remodeling, a key feature in the development of irreversible airways obstruction in asthma and COPD. Secondly, there is growing evidence that atherosclerotic cardiovascular disease is an inflammatory process. PM Centers are testing the hypothesis that immune or inflammatory effects of PM exposure may promote or accelerate atherosclerosis. Thirdly, diabetes is associated with severe, accelerated atherosclerotic vascular disease and increased susceptibility to infection, and a recent study identified diabetics as particularly susceptible to the health effects of PM. Determining the mechanisms involved in this susceptibility of diabetics may help to shed new light on PM effects mechanisms in general.

It is known that ambient air PM, particularly DEP, contain carcinogens, and there is recent epidemiological evidence that mortality due to cancer is increased in relation to PM exposure. Investigating the PM components and mechanisms for carcinogenesis will be an important long-term goal of the PM Centers.

Finally, a major long term goal of the PM Centers is to contribute new scientific data and risk assessment tools and information that will assist in refining air quality standards for PM, and to evaluate the public health benefits of reductions in PM exposure. This will involve more comparisons of PM potency across animal, clinical, and *in vitro* endpoints coupled with ever-increasing specificity as to aerosol characteristics, leading to better indicators of biological mechanism and links of particular sources of PM to specific health effects.

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## ACUTE HEALTH EFFECTS OF PM

### Background

The acute health effects of PM exposures have been extensively examined by a large number of epidemiological studies conducted worldwide. These studies have consistently shown significant associations between daily average ambient PM concentrations and corresponding cardiopulmonary mortality, morbidity, and functional impairments. When EPA promulgated its 24-hour PM<sub>2.5</sub> NAAQS in 1997, it relied primarily on this large body of epidemiological data relating PM exposures to daily deaths and hospital admissions. However, critics of the revised PM NAAQS raised a number of key issues in their challenges to

the credibility of, or need for, a new 24-hour PM<sub>2.5</sub> NAAQS such as: 1) the associations represented deaths of frail individuals whose deaths were brought forward by only a few days or weeks (harvesting), and thus had little public health significance; 2) particles originating from different sources have varying toxicities, therefore, the relative health impacts of particle sources should be assessed prior to regulating their emissions; 3) the associations were potentially confounded by season, weather, and other gaseous pollutants; 4) the associations were implausible because ambient PM<sub>2.5</sub> concentrations were not appropriate surrogates of personal PM<sub>2.5</sub> exposures; 5) the associations were implausible because there was limited support from controlled human and animal studies; 6) the identification of populations susceptible to PM<sub>2.5</sub> health effects is necessary prior to promulgating a new PM<sub>2.5</sub> standard and; 7) the exposure-response curves, showing no thresholds, were unlikely from a biological standpoint.

Many of these issues have been addressed in recent epidemiological and toxicological investigations examining the acute health effects associated with short-term PM exposures. Collaborations between epidemiological and toxicological communities have led to the development of common study hypotheses and common health endpoints, such as lung function, arterial oxygen saturation, heart rate, heart rate variability, blood pressure, tissue biomarkers of effects, exhaled nitric oxide, cardiac dysrhythmias, and respiratory symptoms. As a result, our understanding of ambient PM acute health effects has been advanced substantially. For example, results from recent controlled laboratory studies have shown that short-term exposures to CAPs, as compared to artificially generated particles, result in acute health effects that were comparable to those reported in the epidemiological literature. These toxicological findings provided some evidence about biological plausibility and mechanisms that will be of paramount importance to our efforts to examine the validity of the observed epidemiological study findings.

### **Progress Made**

Since the establishment of the PM Centers, substantial progress has been made in our understanding of PM health effects. Collectively, the PM Centers have addressed a large number of scientific issues regarding acute PM health effects. These investigations are broadly categorized as either observational or controlled studies, and are summarized below.

### **Observational Studies**

**Harvesting:** It has been suggested that air pollution-related deaths mainly impact already frail or sick individuals whose deaths are being brought forward by only a few days (the harvesting hypothesis). If this were true, then PM-related mortality would have little or no importance on total mortality rates. Several studies examining the harvesting hypothesis were conducted by the PM Centers. Using a series of moving averages of mortality and exposure data (7 day, 15 day, etc.), Schwartz (2000a) examined whether the strength of the associations changed over the various averaging periods. Based on the harvesting hypothesis one would expect that estimated PM-mortality associations would become weaker as the averaging periods increased. However, the results from this analysis showed that the association between PM<sub>10</sub> and mortality remained significant, and the estimated relative risks were, in fact, higher for the longer averaging periods. Similar results were found for hospital admissions data (Schwartz 2001). An alternate analytical approach was used in a 10-city meta-analysis study, where averaging periods were increased incrementally from 1 to 45 days. Results from this analysis showed that the PM effect increased by a factor of 2.5, again suggesting significant shortening of life (Zanobetti et al., in press). Similar analyses are currently being conducted to examine cause-specific mortality.

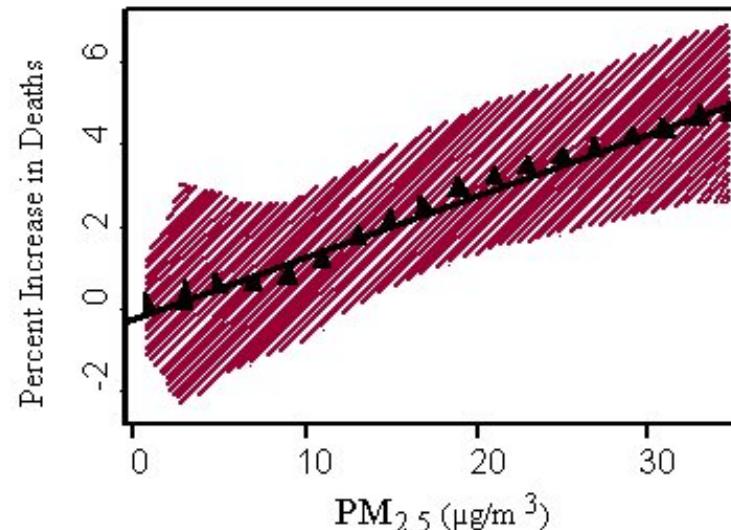
Exposure Response between PM<sub>2.5</sub> and Daily Death

Figure 1. Percent increase in daily deaths in six U.S. cities as a function of community average PM<sub>2.5</sub>. The shaded area represents the 95% confidence interval.

**Threshold/Exposure-Response:** Analytical methods were developed to combine smoothed exposure-response curves from multiple locations to examine whether a threshold in the PM<sub>10</sub> and daily death relationship exists. Results from multiple cities in the U.S. and Spain suggest that the PM<sub>10</sub>-mortality relationships are linear down to the lowest observed exposure concentrations, supporting the no-threshold hypothesis (Schwartz and Zanobetti, 2000; Schwartz et al., 2001). Similar results were found in subsequent studies of PM<sub>2.5</sub> and mortality in six U.S. cities (Figure 1) and of PM<sub>10</sub> and hospital admissions (Zanobetti and Schwartz, 2001a). In the PM<sub>10</sub>-hospital admissions study, the methodology was modified to examine sources of heterogeneity in the exposure-response relationship by calculating a random slope for each city. In the near future, we plan to apply the random slope model to mortality data and to examine other responses to PM exposures, such as electrocardiogram (EKG) changes.

**Particle-Specific Associations:** PM Center investigators have examined the relationship between mortality and source-specific PM concentrations. Laden et al. (2000), for example, used source-apportionment techniques to group elemental PM concentrations from six U.S. cities into a small numbers of categories, or "factors". These factors were attributed to different PM sources, such as vehicular emissions, oil combustion, soil, etc. For each factor, a daily score was calculated. Subsequently, excess daily mortality was regressed against the daily scores using multiple regression analyses. Significant associations were found between mortality and the traffic and coal combustion factors, with the largest effect size for the traffic factor. No significant associations were observed for the oil and soil factors. Mar (2000) applied factor analysis to PM<sub>2.5</sub>, PM<sub>10</sub>, PM<sub>10-2.5</sub>, sulfates, non-soil PM<sub>2.5</sub>, organic carbon, elemental carbon, total carbon, gaseous co-pollutants and cardiac mortality data in Phoenix, AZ. Results from this study showed that combustion-related pollutants and sulfates were associated with cardiovascular mortality.

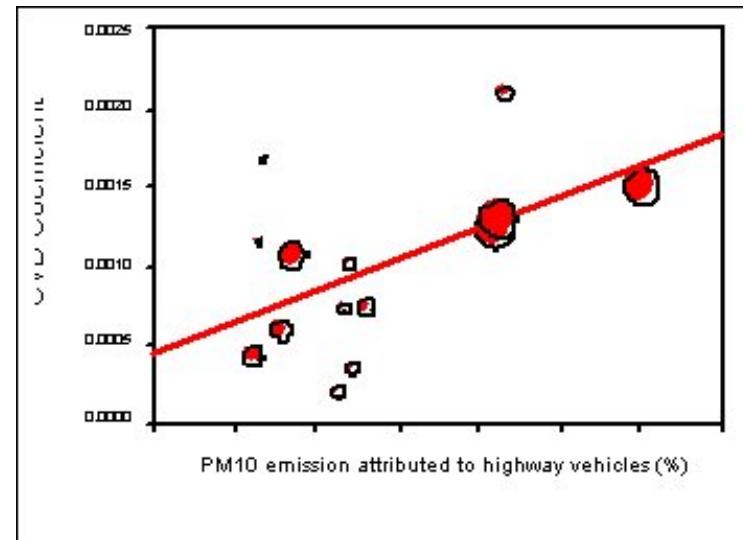


Figure 2. Association of Motor Vehicle PM10 and CVD Hospital Admissions. The size of the symbol reflects the size of the population group studied.

Source-specific effects were also examined by Janssen et al. (2001). The investigators used source emission and home characteristics to explain observed variability in the city-specific PM<sub>10</sub>-hospital admissions coefficients. As shown in Figure 2, the PM<sub>10</sub> coefficient for CVD-related hospital admissions increased with the fraction of PM<sub>10</sub> emissions from traffic-related sources, suggesting higher relative risks from PM<sub>10</sub> for cities with a greater number of traffic-related PM<sub>10</sub> sources.

**Susceptibility:** Several studies have shown higher PM-associated health risks for susceptible subpopulations, such as the elderly or those with existing cardiopulmonary diseases. PM Center investigators have attempted to identify important susceptible subpopulations. Results from these studies have shown that socio-economic factors and race do not affect susceptibility to PM-associated mortality (Zanobetti and Schwartz, 2000); however, females were shown to be at greater risk.

The elderly have long been thought to be particularly susceptible to PM pollution. Consequently, several panel studies have focused on examining the impact of PM exposures on the elderly. In Seattle, the relationship between PM exposures and cardio-pulmonary health effects was examined for three panels of elderly subjects (healthy, with CVD and with COPD). Results from this study showed that during paced breathing exercises, a 10 mg/m<sup>3</sup> increase in outdoor PM<sub>2.5</sub> (lagged by 1 hour) was associated with a 25% (-45%, 01%) decrease in the median of high frequency heart rate variability (HF HRV) in subjects with CVD (Sullivan et al., submitted). Decreases in HF HRV were also observed for 4- and 24-hour lagged periods. No effects were observed either for healthy subjects or those with COPD.

Results from these studies have not been entirely consistent, however, as a recent study showed no significant association between PM<sub>2.5</sub> exposure (0-2 day lag) and coached FEV<sub>1</sub> for subjects with COPD or CVD. In contrast, a decrement in FEV<sub>1</sub> of 215ml for a 10 mg/m<sup>3</sup> increase in local outdoor PM<sub>2.5</sub> exposure was shown in the same study for normal subjects without reported COPD or CVD (Trenga et al., submitted).

Other PM Center-sponsored studies examining whether individuals with pre-existing disease are at increased risk from PM exposures are currently underway. Data collection and analyses for a study in Erfurt, in eastern Germany, of patients with pre-existing CVD or COPD is currently being conducted to examine whether ultrafine particles exacerbate cardiovascular diseases through different mechanisms than PM<sub>2.5</sub> (Wichmann and Peters, 2000). Analyses of 683 EKG recordings and blood parameter analyses are ongoing. Fieldwork for the study on COPD patients started in October 2001 and will be completed in spring 2002.

Children are also hypothesized to be particularly susceptible to PM exposures. Koenig et al. (2002) conducted a panel study of 16 children (aged 6-12 years) with mild-to-moderate asthma living in Seattle. Daily samples of exhaled breath nitric oxide (eNO), a marker of pulmonary inflammation, were collected for each of these children for up to 10 consecutive days. Results from this study showed that a 10  $\mu\text{g}/\text{m}^3$  increase in  $\text{PM}_{2.5}$  was associated with a 4.8 ppb increase in eNO, suggesting that  $\text{PM}_{2.5}$ , at ambient concentrations, can act as an inflammatory agent.

In an additional study conducted in Seattle, 133 children (5-13 years of age) with asthma were observed for an average of 58 days (range 28-112 days) while they were screened for enrollment in the Childhood Asthma Management Program (CAMP) study (Yu et al., 2000). In single-pollutant models, the population average estimates indicated an increase of 18% in the odds of an asthma symptom corresponding to a 10  $\text{mg}/\text{m}^3$  increment in same-day  $\text{PM}_{10}$ , and an increase of 11% for  $\text{PM}_{10}$  lagged 1 day.

More recently, diabetics have been identified as an important susceptible population. In several single-city studies, the risk of PM-associated hospital admissions for heart disease for diabetics was double that for the general population (Zanobetti and Schwartz, 2001b; Zanobetti and Schwartz, 2001c). In addition, diabetics were found to have an increased risk of PM-associated mortality (Bateson and Schwartz, 2001). Individuals with other pre-existing diseases have also been found to be at higher risk. Respiratory illness, for example, was shown to modify the risk of cardiovascular hospital admissions, while heart failure was found to modify the risk of COPD hospital admissions (Zanobetti, Schwartz, and Gold, 2000).

**Confounding:** A new hierarchical model was used to examine the potential confounding effect of gaseous co-pollutants (Schwartz, 2000b). The results of this study suggest that the association between  $\text{PM}_{10}$  and daily deaths was not confounded by gaseous air pollutants. A subsequent examination of the season-specific relationship between PM and mortality data for Philadelphia confirmed that mortality was predominantly associated with  $\text{PM}_{2.5}$  and not  $\text{SO}_2$  (Schwartz, 2000b). Additional information about confounding was provided by exposure studies, which showed that ambient gaseous air pollutant concentrations are not well correlated with their respective personal exposures, but are significantly correlated to personal PM exposures, suggesting that the ambient gaseous concentrations are acting as surrogates for personal exposures to PM (Sarnat et al., 2001.; also, see exposure section, and the findings below).

### Controlled animal and human studies

A large number of controlled exposure studies in humans and animals have been conducted by the PM Centers in an effort to investigate the acute biological responses induced by PM exposures. Some of these studies have used laboratory-generated PM, while others have relied on particle concentrators. Particle concentrator techniques have been developed by aerosol scientists at the PM Centers to specifically serve the needs of their health effects colleagues. The PM concentrators have been extensively used to increase the concentrations of ambient  $\text{PM}_{2.5}$  by a factor between 10 and 100. This makes it possible to simulate upper bound  $\text{PM}_{2.5}$  concentrations on a regular and prolonged basis in order to examine the cardiac and pulmonary function, response biomarkers, and other health endpoints before, during and after exposures.

Results from these studies have repeatedly shown associations between  $\text{PM}_{2.5}$  exposures and a variety of acute responses, providing direct evidence that  $\text{PM}_{2.5}$  is biologically active at current peak exposure levels. As described in the Biologic Plausibility section, health outcomes that may warrant further examination in epidemiological studies include heart rate, heart rate variability, QTc interval changes, arrhythmias and ischemia, blood ICAM-1 and interleukin-6 (IL-6), and oxidant stress markers. Listed below are brief descriptions of a few controlled acute health effects of animals and humans that have been conducted by the PM Centers.

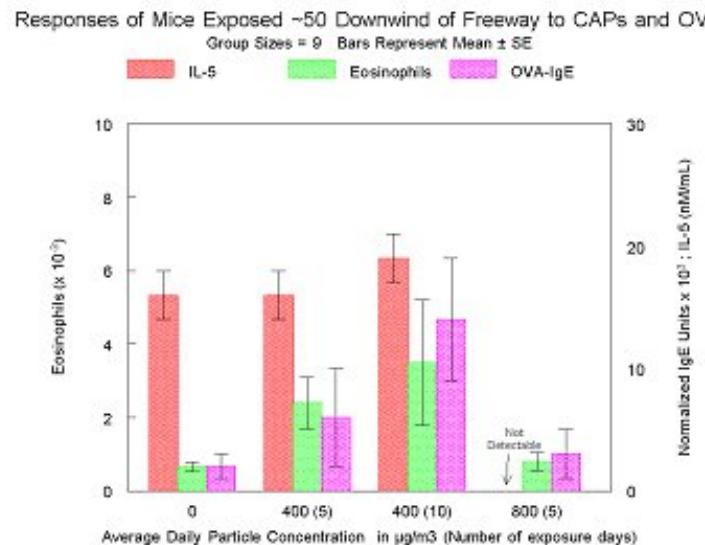


Figure 3. Biomarker responses of sensitized mice exposed to CAPs at 50 meters downwind of a Los Angeles freeway.

**Animal studies:** Ovalbumin (OVA)-sensitized mice were housed in specially equipped trailers located 50 meters downwind of a Los Angeles freeway. These mice were exposed to CAPs and received an inhalation challenge of ovalbumin 2 weeks after their last CAPs exposure. As illustrated in Figure 3, dose-related changes for eosinophils and OVA-IgE were observed for the 5 and 10 day exposures at  $400 \mu\text{g}/\text{m}^3$ , but no apparent response were found for the equivalent doses of  $400 \mu\text{g}/\text{m}^3$  for 10 days and  $800 \mu\text{g}/\text{m}^3$  for 5 days. These preliminary results suggest that high CAPs concentrations can suppress allergic responses, whereas lower CAPs concentrations can stimulate responses.

The age-resolved response of sensitized rodents was examined using 6 hour exposures to laboratory-generated ultrafine carbon particles ( $100\text{-}150 \mu\text{g}/\text{m}^3$ ) with and without  $\text{O}_3$  co-exposures (Elder et al., 2000; Elder et al., submitted). Endpoints evaluated were cellular and biochemical lung lavage analysis and oxidative stress-related parameters of lavage and blood cells, and acute phase proteins. Results showed that age, ultrafine particle concentration, ozone concentration and sensitizing agents were significantly associated with the endpoints. Old rodents were shown to be at an increased risk to greater oxidative stress from combined ultrafine carbon and ozone exposure as compared to young animals.

**Human studies:** Eleven human volunteer subjects, who were either healthy or had asthma, were exposed to inhaled carbon ultrafine particles by mouthpiece for two hours ( $\sim 2 \times 10^6$  particles/cm $^3$ ; count median diameter=22 nm) (Frampton et al., submitted). Healthy subjects showed no significant response to exposure, as determined by symptoms, spirometry, pulse-oximetry, exhaled NO, or sputum cell differential (counts compared to air control). Polymorphonuclear leukocyte (PMN) expression of ICAM-1 and leukocyte function-associated antigen (LFA-1) decreased 3.5 hours after exposures, but to a greater degree after ultrafine particle exposure than filtered air exposure.

For healthy subjects (n=12), an ultrafine count concentration-response decrease in soluble CD40L was seen compared with air exposure ( $p=0.006$ ) (Daigle et al., submitted). An interim analysis has been performed on eight subjects with asthma. CD40L expression on monocytes, a marker of adverse inflammatory responses, increased after PM exposure relative to air exposure ( $p=0.047$ ). There were no changes in lung function or airway production of NO. These observations are the first evidence of CD40-CD40L changes following exposures to ultrafine particles and are consistent with previous findings of altered leukocyte-endothelial interactions after such exposures.

Human volunteers were exposed to PM<sub>2.5</sub> CAPs in Los Angeles. Exposure to PM<sub>2.5</sub> was shown to induce the following health outcomes: decreased heart rate variability in healthy young adults; increased blood ICAM-1 (indicating increased inflammation and coagulability), which was similar in healthy and asthmatic adults; marginally significant increases in serum IL-6, an acute phase reactant, in asthmatics; transient decreases in arterial oxygen saturation in elderly subjects; decreased heart rate variability in elderly subjects; a greater number of supraventricular and ventricular ectopic heartbeats in elderly subjects; and increased IL-6 in induced sputum, suggesting increased airway inflammation.

Although many of these controlled animal and human studies are still under way, their results are beginning to elucidate the roles of key exposure variables on biological responses. These findings not only support the epidemiological observations, but also provide new information about the biological outcomes that can be measured in field studies.

## **Short-Term Goals**

During the next several years, the PM Centers will continue to develop and apply new analytical techniques to address important scientific issues relating to harvesting, confounding, exposure-response relationships and susceptibility. The novel statistical approaches developed for evaluating harvesting will be applied to additional U.S. populations for a variety of health outcomes. In addition, we will use these new methodologies to examine the relationship between acute and sub-acute effects. These investigations will, in turn, provide valuable insights for our efforts to quantify chronic PM health effects.

Furthermore, we will continue to investigate the potential for confounding by gaseous co-pollutants and the exposure-response relationships in a variety of urban environments with different mixtures of gaseous and particulate pollutants. The results from these studies will be compared to those obtained in Philadelphia using the same analytical methodologies.

Over the past few years, we have been very successful in identifying susceptible populations. Our studies suggest that individuals with cardiac and pulmonary diseases are more vulnerable to PM exposures. More recently, diabetics have also been identified as an important susceptible population. Given the large number of subjects analyzed in the observational studies, these investigations will continue to be critical in our efforts to understand susceptibility. Indeed, based on the results of previous observational studies we have been able to develop animal models replicating human susceptibility.

Investigation of the relationship between particle composition or source characterization and adverse health outcomes will continue to be one of the main focuses of PM Center research agenda, and the data now being generated by EPA's speciation and Supersite monitoring programs will be used in this endeavor. We will also investigate the impact of DEP exposures on the exacerbation of asthma. Similarly, we will examine the relationship between freshly generated ultrafine particles from mobile sources and children's acute health effects using the residence location relative to major interstate roadways as a marker of exposure.

The PM Centers observational studies will be supplemented by a series of animal toxicology studies that will also be completed during the next few years. The main objective of these controlled studies will be to investigate the pulmonary and cardiovascular effects induced by exposures to concentrated fine and ultrafine particles and gaseous co-pollutant mixtures. Of particular interest will be identification and evaluation of susceptible models. For example, we will conduct studies exposing mice and rats to concentrated fine and ultrafine particles at varying distances from high-volume interstate highways in southern California to determine the effects associated with freshly generated vehicular emissions. Also, collaborative studies will be performed to examine the variability in the PM-induced biological responses in animal hosts (e.g., pulmonary immunomodulation) as a function of particle composition. Towards this end, the PM Centers will collect and exchange PM<sub>2.5</sub> samples containing particles of substantially different physico-chemical characteristics.

Collectively, the acute observational and controlled investigations will enable us to enhance our understanding about: the nature

of transient cardiac function changes associated with short-term peaks in PM exposures; the role of underlying ischemia on associations between short-term peaks of PM exposure and incident myocardial infarction and; the role of underlying respiratory disease on associations between PM exposures and heart rate variability.

### **Long-Term Goals**

We anticipate that many of the scientific issues addressed in the above list of short-term goals will not be adequately resolved during the next 2-3 years. Therefore, it is likely that research on many of these issues will comprise much of our long-term agenda on acute PM health effects. Among these issues will be research investigating factors, both environmental and genetic, that explain human susceptibility. In addition, we expect that future collaborative investigations between epidemiologists and toxicologists will lead to the development of better biomarkers of PM effects. Finally, PM Center efforts aimed at quantifying the acute health effects of PM exposures will, ultimately, assist in the creation of new chronic PM health effects models.

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## CHRONIC HEALTH EFFECTS OF PM

### Background

As discussed in the previous section, a plethora of PM acute health effects studies have been conducted to date. In contrast, much less information is available on chronic effects associated with PM exposures. This is due to the complexity and cost of chronic studies.

The most frequently cited PM chronic health effect studies are the Harvard Six Cities Study (Dockery et al., 1993) and American Cancer Society (ACS) Cohort Study (Pope et al., 1995). They found increased mortality rates (decreased life expectancy) in cities with higher average ambient PM<sub>2.5</sub> and sulfate concentrations. Differences in city-specific mortality rates were not explained by data on individual risk factors. Since these studies provided most of the justification for the annual PM<sub>2.5</sub> NAAQS in 1997, they generated a number of concerns that were expressed in public comments that questioned: 1) the validity of underlying study findings due to the lack of public access to raw data; 2) the need to further consider city-specific characteristics and other alternative explanations of the observed differences in mortality rates; 3) the adequacy of controls for the individual characteristics such as age, smoking, occupation, obesity, and socio-economic factors; and 4) the appropriateness of ambient PM measurements as surrogates of community personal exposures.

In addition to the mortality of adults, there were reports of increased respiratory effects in children associated with long-term PM exposures. The Harvard Six and Twenty-four Cities cross-sectional studies observed higher rates of respiratory symptoms and lower lung function for children in cities with higher average PM<sub>2.5</sub> and acidic sulfate concentrations. Concerns expressed in public comments were similar to those expressed for the mortality studies, except for the influence of smoking and occupation.

There were effectively no animal studies of mortality or other morbidity endpoints of chronic PM exposures that were consistent with the epidemiological findings. Long-term studies had shown increased lung cancer in rats exposed to very high concentrations of DEP or carbon particles (possibly related to the particle clearance overload they produced).

Because of the high visibility of the Six Cities and ACS cohort studies, and their influence in the standard setting process, the Health Effects Institute (HEI) undertook sponsorship of a comprehensive independent validation and reanalysis of these two mortality studies. The HEI project (Krewski et al., 2000) validated the quality of the original annual mortality study data, replicated the original findings, and demonstrated the validity and robustness of Six Cities and ACS Mortality Studies findings. For both of the cohorts studied, PM-associated mortality risk was highest for individuals with less than high school educations.

Data from other chronic exposure mortality studies have been limited. Survival analyses of non-smokers in California (the AHS/SMOG study) reported increased mortality associated with PM<sub>2.5</sub> concentrations (Abbey et al., 1999). Preliminary analyses of male veterans being treated for hypertension reported no statistically significant increased mortality associated with fine particle concentrations (Lipfert et al., 2000).

### **Progress Made**

**Annual Mortality Cohort Studies:** Two of the PM Centers have been engaged in continued follow-up of the original Six Cities and ACS cohorts respectively for an additional nine years. New data on occupation and other individual characteristics, and new analytic methods developed in the HEI re-analyses were applied in both studies. These recent findings are illustrated in Figure 1. The updated ACS study involves the analysis of more extensive PM<sub>2.5</sub>, sulfate, and gaseous co-pollutant data. For the Six Cities cohort, PM<sub>2.5</sub> and sulfate concentrations continued to be associated with decreased survival, and with increased mortality from cardiovascular and pulmonary causes (Laden et al., 2001). In addition, increased lung cancer deaths were significantly associated with PM<sub>2.5</sub> and sulfates in the extended follow-up. For the ACS cohort, PM<sub>2.5</sub> and sulfate also continued to be associated with increased cardiovascular and pulmonary mortality, and lung cancer (Pope et al., submitted). The excess risks in the ACS cohort were seen only among individuals with less than high school educations in these extended re-analyses.

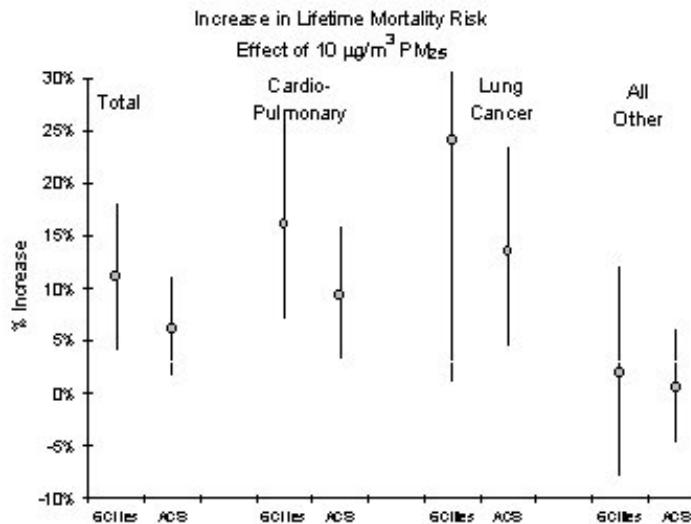


Figure 1. Mean increase and 95% confidence intervals for annual mortality rate increases per 10 µg/m<sup>3</sup> increment of PM<sub>2.5</sub> for the 6 cities and ACS cohorts based on 16 years of mortality data.

**Effects of Subchronic Exposures:** Recent analyses have attempted to bridge the time spans for health effects observed in studies of acute daily exposures versus long-term chronic exposures. Analyses of the association between daily mortality and hospital admissions with PM concentrations during the preceding weeks to months have highlighted the importance of subchronic exposures. In Boston, for example, an increase in the two day average PM<sub>2.5</sub> of 10 mg/m<sup>3</sup> was associated with an increase in mortality by 2.1%, while for the same increase in monthly average, mortality increased by 3.8% (Schwartz, 2000). In the ACS cohort study, this same increase in annual average PM<sub>2.5</sub> was associated with a 6.8% increase in mortality .

**Children's Lung Growth Cohort Studies:** Studies of chronic effects of PM exposure on the respiratory health of children have been conducted by two of the PM Centers. As shown in Figure 2, recently reported results from the Children's Health Study (CHS) showed that PM<sub>2.5</sub> is significantly associated with slower growth of lung function in children residing in communities with higher than average annual PM<sub>2.5</sub> concentrations. Figure 3 shows that children who have moved from the high PM areas into areas with lower PM did not recover their lost lung function, but had subsequent rates of lung function growth equal to that of the children in their new communities. Children who moved from low PM areas to communities with higher PM levels had less lung function growth than children who remained in the low PM areas (Avol et al., 2001). The results of these analyses have provided a basis for follow-on studies of intra-community variations in response that are supported by PM Center funds. The focus of these recent and future studies is on proximity to heavily traveled express roads as an independent risk factor.

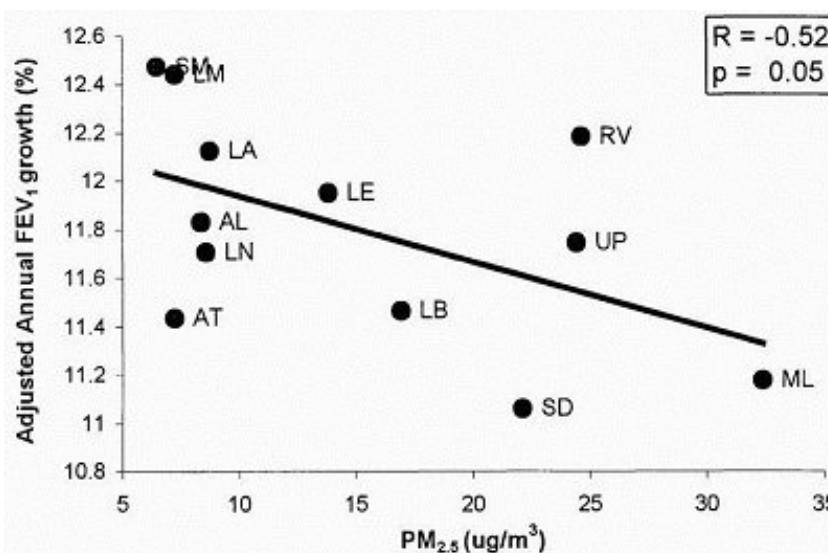


Figure 2. Adjusted annual FEV<sub>1</sub> growth (%) versus average PM<sub>2.5</sub> concentrations among children in 12 communities in southern California (Gauderman et al., 2000).

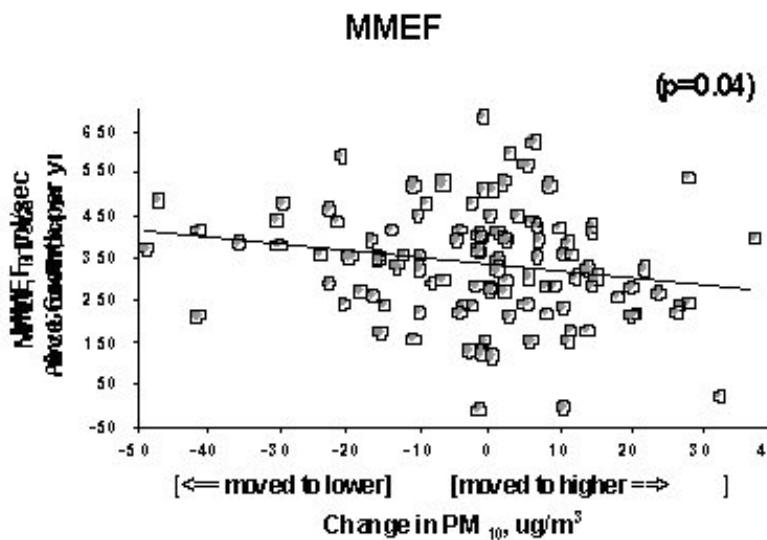


Figure 3. Adjusted annual lung function (MMEF) growth (%) versus change in average PM<sub>2.5</sub> concentrations among children who moved in the Southern California Children's Study (Avol et al., 2001).

These results have also stimulated PM Center plans for follow-up studies of the cohorts of children from the Six and Twenty-four Cities studies. Fourth and fifth grade children in the Twenty-four Cities study showed lower lung function associated with community specific PM<sub>2.5</sub> concentrations. Many of these children have now been retested as mature twelfth graders, and their lung growth will be compared to community air pollution levels as was done in the Southern California study.

### **Short-Term Goals**

The follow-up and data analysis on the Six Cities and ACS study participants will continue to assess source specific characteristics of PM responsible for chronic mortality (longevity reduction) effects. This will include the assessment of individual characteristics (disease state, socio-economic status, smoking, occupational exposures) that make study participants more susceptible to effects of PM on survival. Air pollution will be treated as a time dependent covariate in the Six Cities cohort to determine how much of the association with mortality in the prospective cohort study is due to exposure in the past year, as opposed to over a lifetime. Estimates of the distribution of years of life lost associated with PM air pollution in the Six Cities cohort will also be computed. Further studies of the ACS cohort's longevity reduction will focus on the relationship between mortality and PM composition and/or source contribution. This will be accomplished by using particle speciation data, both the historic dichotomous sampler network data, and the new speciation site data, and source apportionment techniques. The association between PM<sub>2.5</sub> and/or sulfate and local airport visibility will be determined for each community where suitable data are available. City-specific relationships between pollution and visibility measurements will be used to estimate PM<sub>2.5</sub> levels prior to and after the limited period for which direct measurement data are available in an effort to investigate the relative roles of past and current exposures.

Analyses of data previously collected on cohorts of children from studies performed by PM Center investigators (24 Cities and Southern California CHS) will be pooled in order to assess effects of PM from different source classes (e.g., vehicular versus power plant) and composition (e.g., nitrate versus sulfate). Each of these cohort studies assessed fourth and fifth grade school children using the same questionnaires and pulmonary function measurements. The 24 Cities study assessed the effects of sulfate particles from coal-fired power plants. The Southern California study assessed the effects of nitrate particles from vehicular traffic. The combined data set will assess chronic health effects in these children versus PM<sub>2.5</sub> mass and composition data.

A new epidemiological study of participants in the NHLBI Womens' Health Initiative Observational Study (93,000 women aged 50-79 yrs from 40 centers around the country) is currently underway. The women are being observed for the occurrence of cardiovascular disease and will be matched with community air pollution levels from ambient monitors. The effects of chronic exposure to ambient PM on the incidence of cardiovascular disease will be assessed in this cohort using a proportional hazards model approach.

In prior epidemiological studies in Erfurt and Augsburg, Germany, acute effects of ultrafine particles on daily mortality (Wichmann et al., 2000, HEI report) and on myocardial infarction (Peters et al., 2001) were observed. Cohorts that were established in these cities will be used in the future to investigate whether there are long-term effects of exposures to ultrafine particles.

A PM Center subchronic animal inhalation study using New York CAPs will begin in the Spring of 2002. Normal and cardiac disease susceptible mice will be exposed for 6-hours/day, five days per week, for six months, with or without intermittent ozone exposure. Cardiac and respiratory function will be monitored periodically and biochemical and genetic biomarkers of responses will be investigated in tissues and lung lavage cells from the exposed animals. In another study, mice will undergo infectious bacterial challenge prior to CAPs exposures to determine possible PM exposure-related enhancement of their susceptibility to infection. These studies will thereby assess health endpoints being evaluated during acute CAPs exposures of animals at several of the PM centers, and of humans at the EPA Clinical Studies Laboratory in Chapel Hill, NC, and determine whether such acute effects progress to chronic changes that could lead to enhanced susceptibility to PM exposures.

### **Long-Term Goals**

Based on our previous experience, repeated follow-up of existing cohorts can be of paramount importance in understanding the association between chronic PM exposures and human health. Results from the Six-Cities and Children's Health Studies, for

example, have enabled us to understand the effects of air pollution on children's lung growth. Collectively, the PM Centers have already investigated numerous cohorts that span ages, ethnicities, geographic locations and that are exposed to varying PM levels and compositions. Health and exposure history data for these cohorts are also available. Information from these numerous study locations will be combined to increase the statistical power of existing chronic health effects models. The range of data will, in turn, allow us to better examine the role of PM composition, gaseous co-pollutants, ethnicity, exposure history, age and climate on chronic PM health effects. Therefore, it would be advantageous for the PM Centers to allocate a large fraction of their resources during the next 5-10 years to continue with the follow-up for these existing cohorts.

As new scientific information emerges, providing better indicators of air pollution health effects, questionnaires and medical examinations will be amended accordingly. For example, the early cohort studies of populations initially recruited in the mid-seventies focused on the impact of air pollution exposures on respiratory health. Therefore, investigations centered on collecting detailed information on respiratory health. Recent studies have demonstrated the influence of particles and air quality on cardio-vascular health. Correspondingly, information on cardiac health has assumed a more central role in current studies. Although limited information currently exists on the effect of air pollution among susceptible populations, future knowledge may require a better understanding of factors predisposing these individuals to adverse health outcomes. Of particular interest is the gene-environment interaction. Research that integrates the findings from the Children's Health Study with new information on traffic density and the organic constituents in traffic related PM will also be pursued as a long-term goal.

For chronic studies using CAPs-exposed animal models, the specific hypothesis to be addressed in future years will be based, in part, on the findings of the first subchronic exposure study to be conducted in New York. This study will examine the possible acceleration of atherosclerotic plaque development, increased reactive or obstructive airway disease, reduced lung capacities, enhanced susceptibility to infectious agent exposures, and altered gene expression. Moreover efforts will be made to determine whether variations in responses during the exposures can be related to the day-to-day variations in the chemical composition of the CAPs. Based on the results from this study, the following parameters may be considered in future chronic exposure studies: 1) including additional animal models to replicate human susceptibility; 2) increasing exposure durations and; 3) examining co-exposures to CAPs with one or more gaseous co-pollutants. Of additional importance will be the investigation of chronic health effects thresholds by conducting subchronic exposure studies at multiple PM concentrations to determine the existence of thresholds, if any, and replication of one or more of these studies in areas where the PM composition is different. Finally, we expect that the findings from the controlled animal studies will assist in further refining study designs for our human chronic health effects investigations.

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## DOSIMETRY

### Background

A critical link in the evaluation of the relationship between individual exposures to PM and health responses is dosimetry. Dosimetry research investigates not only the amounts and distribution of the deposited PM in the respiratory tract, but also the pathways by which this material is translocated to other sites in both the respiratory tract and to more distal organ systems. Furthermore, knowledge of inter- and intra-species differences is critical to our effort to extrapolate results from experimental studies to the population-at-large.

Prior to the establishment of the PM Centers, studies of PM dosimetry in lung airways concentrated largely on healthy adult humans, although there were a few studies of children and adults with chronic respiratory disease. However, there was very little research conducted that examined deposition in animal models that are currently being used in studies of PM health effects as surrogates of susceptible human populations. Mathematical deposition models derived from experimental data had been developed, and were largely used for predicting total and regional deposited doses. Mechanisms for clearance of deposited particles had also been studied, and major clearance pathways in the respiratory tract regions had been well described. However, several major gaps in our understanding of particle deposition and clearance remained, including detailed analyses of size-resolved PM deposition and clearance, especially for ultrafine particles, and clearance mechanisms for PM components, as well as their translocation pathways.

Research addressing these gaps is important for the interpretation of toxicological and epidemiological findings suggesting effects on cardiopulmonary systems, which could be due to indirect (via biological mediators initiated from acute pulmonary effects) or direct or neuronal function changes. The multidisciplinary team of PM Centers investigators provides a great advantage in addressing these questions.

## **Progress Made**

Significant advances have been made at the PM Centers in a number of critical areas. These include development of techniques for the production of hollow lung airway casts of potentially susceptible people and evaluation of dosimetry of specific fractions of ambient PM that may be especially toxic. There has also been work on dosimetry in humans and in animal models being used in PM studies, using both ambient PM as well as surrogate particles.

To address the paucity of data regarding PM deposition in the lungs of people with pre-existing pulmonary disease, a pilot PM Center project investigated the potential for retrieval of morphometric data from three-dimensional images of tracheobronchial airways obtained *in vivo* by x-ray Computerized Tomography (CT). The study also explored the potential for the use of stereolithography (STL) to produce hollow airway casts of normal and abnormal lung airways for the determination of site-specific deposition and for experimental verification of particle deposition models. A volumetric rendering of the interior surface of a hollow airway cast (used in previous studies) was generated, producing a surface representation of the airway tree. These three-dimensional images were then converted to a STL file format required for the rapid prototyping of airway casts. The STL unit uses a computer controlled arm connected to a plastic extrusion device to build volumetric structures layer-by-layer. Figure 1 demonstrates the close concordance between an original hollow airway cast and the replicate made of it by STL (Won et al., 2000a,b).

Thin multi-slice helical CT scanning allows for the acquisition of high resolution volumetric image data sets of the lung in a breath-hold or at multiple phases within a respiratory cycle for children and the elderly and people of all ages having asthma or chronic obstructive lung disease. From these scans, hollow airway casts that include 5 or 6 bronchial generations can be created and replicated for use in studies of inhaled particle deposition in replicate casts of both healthy and diseased airways using realistic air flow rates.

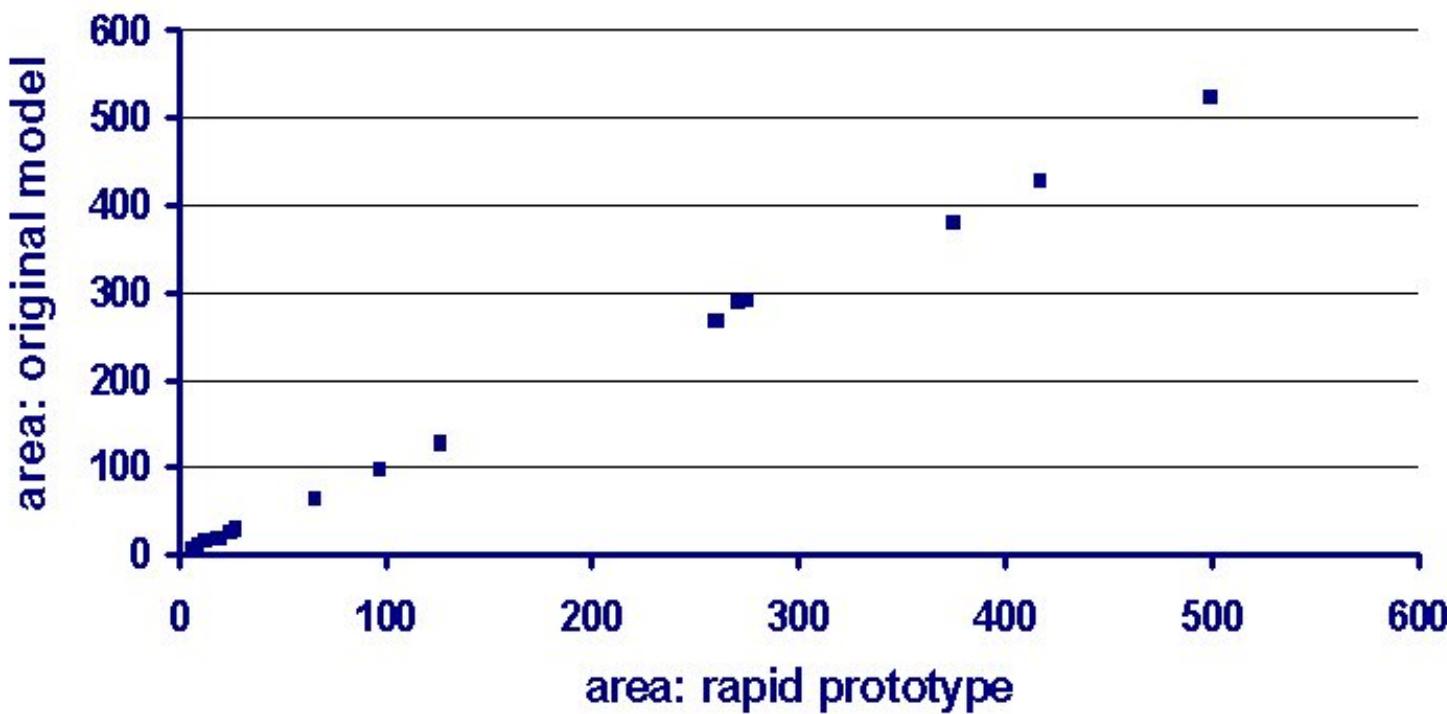


Figure 1. Cross sectional luminal airway surface of original hollow airway cast made from a normal human tracheobronchial tree in mm<sup>2</sup> vs. corresponding airway surface in mm<sup>2</sup> of a replica produced by stereolithography using data obtained by CT-scanning of the original cast.

PM Center methodology was developed to determine total lung deposition of CAPs in dogs. These studies were relevant to animal models of cardiac disease used in the PM Center research. The methods included the use of a breath-by-breath respiratory monitoring system that provided both rate and tidal volume as well as measurement of inhaled and exhaled particle number classified by size. These measurements used both a TSI Scanning Mobility Particle Sizer (SMPS) for particles in the ultrafine and smaller fine ranges, and an Aerosizer for particles in the fine particle size range. The canine studies showed deposition of ambient particles across the size ranges studied to follow a similar pattern to that described in the International Commission on Radiological Protection (ICRP) human particle deposition model (ICRP, 1994). However, the measured deposition fraction was slightly greater than that predicted by the ICRP model. This method was, subsequently, used in a study of six human subjects breathing ambient air without any enhancement of particle concentration. In all subjects, total respiratory deposition fraction for each measured size range ( $> 10$  nm) followed the same pattern as predicted by the ICRP model. In some individuals, deposition fraction for each size range did exceed the predicted deposition fraction. Human studies of ambient particle deposition are important to validate deposition models.

In vivo deposition studies of ultrafine particles are currently being conducted in humans and rats. These studies were made possible through close multidisciplinary interactions between clinicians, toxicologists, physicists, and analytical chemists. For the human studies, a system was developed for mouthpiece exposures with alternating rest and exercise every 15 minutes. Total

respiratory deposition fractions (DF) for particle number and mass were determined. Use of a SMPS allowed size fractionated deposition analysis down to 7 nm particles. Ultrafine carbon particles with a count median diameter of 22 nm were generated. Eleven non-smoking, healthy subjects and eleven non-smoking subjects with mild asthma were exposed for two hours. Results showed that the total respiratory deposition of inhaled ultrafine particles is high relative to fine particles in healthy subjects (DF =  $0.63\pm0.03$ ), and is further increased during exercise (DF =  $0.83\pm0.04$ ), with enhanced deposition in asthmatics (rest DF =  $0.77\pm0.05$ ; exercise DF =  $0.86\pm0.04$ ). These results suggest that asthmatics may be at greater risk from exposure to ultrafine particles because of increased deposition in central airways.

Deposition rates for size-resolved ultrafine particle data showed that the smallest (7 nm) particles had the highest total deposition (~80%). Deposition efficiency for 100 nm particles was ~45%. These deposition rates are in good agreement with the ICRP particle deposition model (ICRP, 1994). This model predicts that ambient ultrafine particles of 20 nm will have the highest overall deposition efficiency, as well as the highest deposition in the gas-exchange region (Chalupa et al., submitted a,b; Frampton et al., 2000a,b).

Experiments in rats were performed using two different types of ultrafine  $^{192}\text{Ir}$  particles and carbon particles containing the stable isotope  $^{13}\text{C}$  particles. The basic design of both rat studies was the same, i.e., exposure to the ultrafine particles followed by serial sacrifice in the post-exposure period and analysis of excised lungs and extrapulmonary organs for  $^{13}\text{C}$  and  $^{192}\text{Ir}$ , respectively. However, there were major differences; the  $^{13}\text{C}$  exposure occurred for 6 hrs in compartmentalized whole-body exposure chambers, whereas the  $^{192}\text{Ir}$  exposures occurred via a 1 hr intratracheal inhalation in anesthetized rats.

For the  $^{13}\text{C}$  exposures, the median particle size was in the range 20-29 nm. Exposure concentrations ranged from 80-180  $\mu\text{g}/\text{m}^3$ , and organ burdens were determined in rats in the first series of experiments at 0.5, 18 and 24 hours after exposure. Six unexposed rats served as controls. Lung lobes, liver, heart, kidney and brain sections (olfactory, cerebrum, cerebellum) were analyzed for  $^{13}\text{C}$  by isotope ratio mass spectrometry (MS). On average ~9 ng  $^{13}\text{C}/\text{g}$  lung per  $\mu\text{g}/\text{m}^3$  of exposure was found in the lung, much less than expected based on predictive lung deposition models. Significant amounts of  $^{13}\text{C}$  had accumulated in the liver by 0.5 hr post-inhalation only at the high exposure concentration of 180  $\mu\text{g}/\text{m}^3$ , whereas by 18 and 24 hrs post-exposure all liver samples showed significantly increased  $^{13}\text{C}$ . Indeed, the amount of total  $^{13}\text{C}$  in the liver at those timepoints exceeded the amount retained in the lung, demonstrating a fast translocation of ultrafine carbon particles to the liver. Other extrapulmonary organs analyzed for  $^{13}\text{C}$  did not show significant increases by 24 hrs post-exposure (Oberdörster et al., submitted).

Results were different for ultrafine Ir particles. Iridium was found in pre-test studies to be essentially insoluble. In these studies, the median particle size was ~15 nm. Gamma-spectroscopic analysis for  $^{192}\text{Ir}$  was performed at timepoints ranging from 6 hr to 7 days post-exposure. The ultrafine  $^{192}\text{Ir}$  particles, after an initial fast tracheobronchial clearance, were essentially retained in the lung; only minute amounts were found in extrapulmonary tissues (~0.5% in bone and soft tissue [muscle], <0.1% in liver, and even less in heart and brain). Soluble Ir was excreted via urine (60% over 7 days), 8% remained in the lungs, and 10% were retained in both soft tissue and bone (Kreyling et al., submitted). These results show that translocation of poorly soluble ultrafine particles to extrapulmonary sites appears to be highly dependent on the chemical nature of the particles. Carbon particles were to a large degree translocated to the liver, whereas metal (iridium) particles were not. These results raise a number of questions that need to be addressed in future studies, including the evaluation of pathways for ultrafine particle translocation (lymphatic, blood vessels, GI-tract, nasal vs. tracheobronchial vs. alveolar region) and also binding of ultrafines to proteins.

Since currently-available inhaled particle dose models provide estimates of averaged doses (i.e., environmental aerosol concentrations) they do not take into account the true PM heterogeneity of tissue doses that occur in the lungs. Higher than average doses can be expected for those people exposed near local particle sources, those who have high specific ventilations (ratio of air intake to body mass), and those who have heterogeneous deposition of particles within various regions of the respiratory tract. Thus, exercising adults and children with lung diseases who live near heavily used freeways may be receiving greatly elevated particle doses at numerous sites within their lungs.

Similarly, the available software used for computing inhaled particle deposition cannot identify local populations of cells that may be of toxicological interest. The numbers of cells that must be significantly damaged in order to seriously impact vulnerable individuals is not yet known. These issues were addressed by a PM Center workshop in October, 2001, which developed a framework for estimating expected local tissue dose concentrations. This framework was applied to Southern California Supersite datasets, and local doses to sites containing the highest exposed 100 cells at each bifurcation in the tracheobronchial tree were calculated for heavily exposed individuals. These local bifurcation area doses were compared to the doses applied to cells in in vitro studies of PM effects. The high in vitro doses corresponded to estimated airway bifurcation PM doses potentially occurring in the lungs of individuals living in the Los Angeles basin.

### **Short-Term Goals**

In a successor project to the pilot feasibility study for the production of hollow airway casts that faithfully reproduce the in vivo dimensions, in vivo studies are being conducted of particle deposition in anaesthetized sheep at the facilities of study collaborators at the University of Iowa using 5 µm diameter radio-opaque droplets. This involves development of analytical programs to examine the CT scan data. The second phase will be to examine changes in the deposition pattern and efficiency when inhalation is done at different points of the inspiratory cycle. The computer controlled respirator at the University of Iowa facility can produce almost any breathing pattern and key the aerosol delivery to any point in the respiratory cycle of the anesthetized sheep. When quantitation has been accomplished in vivo, hollow airway casts of the sheep lung will be produced using the methods developed in the initial PM Center pilot study. PM deposition patterns and efficiencies will then be determined using an artificial thorax and methods and models previously used at NYU to measure particle deposition in the hollow cast systems. Successful development of the test aerosol, and quantitation methods, will ultimately allow future exploitation of these techniques for in vivo studies in both healthy people and those with compromised lung function. In addition to determining deposition efficiency (DE) and pattern studies, PM Center studies will explore the potential for identifying bolus deposition in the sheep lung and the extent to which assumptions of standard bolus deposition experiments are valid. The system will allow testing of the hypothesis proposed by C. Kim and colleagues at the U.S. EPA, that regional deposition can be accurately assessed in people via a series of bolus inhalation experiments.

Other PM Center dosimetry studies will continue to focus upon ambient particles and their diurnal and temporal variation in concentration and composition. The number of subjects will be expanded as well as the number of repetitions per subject. This will permit definition of the range of individual differences in particle deposition fractions including male-female and age differences. In addition, the relationship of deposition fraction to day-to-day compositional differences will be explored to determine the factors important in variations in deposition fraction.

Research will continue on ultrafine particle deposition, disposition and chemistry. Investigations will include: the continued study of susceptible groups (e.g., COPD, elderly) in terms of total respiratory tract deposition; the effects of changes in tidal volume and respiratory rate in deposition; deposition efficiencies in different anatomical compartments of the respiratory tract; clearance and translocation pathways via the respiratory and GI-tracts; translocation following the initial phase of accumulation in the liver; the liver as a storage organ for distribution to other organs; the mechanisms of particle translocation the role of particle chemistry; the fate of organic carbon particles; the efficiency of ultrafine particle translocation along sensory nerves in the conducting airways; and the long-term consequences of ultrafine particle translocation to extrapulmonary organs like the heart.

Answers to these questions are important for the interpretation of results of toxicological and epidemiological studies with respect to effects of inhaled particles on the cardiovascular system that could be due to indirect (via biological mediators initiated from acute pulmonary effects) or direct (ultrafine particles interacting with cardiac or endothelial cells) or neuronal functions effects.

To better understand the generalizability of controlled animal PM exposures to human health, the regional inhaled particle depositions in mice from the freeway study will be determined. Towards this end, replica airway casts of 30 Balb/c mice (15

controls and 15 sensitized) will be prepared and morphometric measurements of airways will be conducted. The mice will be exposed to three sizes of electrically discharged fluorescent monodisperse polystyrene latex particles. Their lungs will be digested and particles deposited in the lungs will be recovered and counted using a fluorescence-equipped microscope. These measurements will be used for examining the toxicologic responses of the sensitized model, as well as for performing extrapolations to humans.

### **Long-Term Goals**

The results of the in vivo particle deposition studies in sheep in vivo will provide a firm basis for a study of human subjects. The future human in vivo studies will focus on: 1) application of accepted mathematical dosimetry models to individuals, utilizing the morphometric data retrieved from the images. This will be assisted by respiratory function test results that will be available for these individuals; 2) measurement of detailed particle deposition data for a range of breathing patterns and particle sizes in hollow cast models of the airways of individuals representative of the various groups of interest; and 3) reconciliation of the results calculated from the current models with experimental data to produce verified empirical deposition models that can be used to better predict inhaled dose based on metrics of exposure to ambient PM.

Future research to relate airborne PM to improved dosimetric models will be directed toward: 1) defining the population receiving the highest local doses in their tissues; and 2) defining the appropriate particle doses for use in in vitro mechanistic studies. Research is also needed to address: 1) the environmental heterogeneity of PM-associated pollutants; 2) how much time susceptible subpopulations spend in such high-concentration areas; 3) ventilation rates of those exposed; 4) heterogeneous deposition patterns of inhaled particles; 5) dose implications of impaired clearance (as is seen in some disease states) and sequestration of particle associated substances; 6) vulnerable target cells in the tissues; and 7) realistic target particle doses that can be used for the design and interpretation of in vitro mechanistic research.

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## **EXPOSURE ASSESSMENT**

### **Background**

As noted in the Acute Effects section, results from daily mortality and morbidity time-series analyses provided much of the scientific basis for setting the particulate matter (PM) standards in 1997. These epidemiological studies typically used PM mass concentrations measured at single outdoor monitoring sites as surrogates of population exposures to ambient air PM. The extent to which outdoor measurements accurately reflect PM exposures has been the subject of considerable scientific debate. Results from early exposure studies such as those conducted as part of the Harvard Six Cities Study and the EPA Particle Total Exposure Assessment Methodology (PTEAM) Study, for example, suggested that personal PM exposures may differ substantially from outdoor concentrations due to contributions from indoor sources. Cross-sectional analyses of these data showed weak associations between daily outdoor PM concentrations and corresponding personal exposures, which were attributed to inter-subject variability and the limited number of measurements (~1-2 days) for each individual. Consequently, the existing PM exposure database was considered inadequate for investigating associations between personal exposures and outdoor concentrations, and longitudinal exposure studies were proposed.

Upon completion of the 1997 PM NAAQS review and prior to the establishment of the five PM Centers, a series of longitudinal PM exposure studies were funded by the EPA, Health Effects Institute (HEI), Electric Power Research Institute (EPRI), Department of Energy (DOE) and American Petroleum Institute (API). The main objective of these studies was to investigate associations, over time, between personal PM exposures and outdoor PM concentrations, with specific focus on characterizing exposures for individuals thought to be especially susceptible to PM-associated health effects. EPA-sponsored research projects were conducted by groups from Harvard University, New York University and the University of Washington. The three research groups collaborated closely in the design and preparation of field studies and shared similar sampling procedures and questionnaires in an effort to create compatible data sets. As part of these early longitudinal studies, the exposures of several cohorts of susceptible individuals, including senior citizens, children, and individuals with COPD or CVD were measured for periods ranging from one to two weeks. Field studies were conducted during both the summer and winter and in a variety of urban and suburban environments, including Atlanta, Baltimore, Boston, Nashville, New York and Seattle. Although analyses of the entire body of data are still in progress, several papers have been published and have been cited in the 2001 PM Criteria Document external-review draft. EPA's Office of Research & Development (ORD) is planning to utilize this rich database to develop both acute and chronic exposure models.

A major finding of these studies is that stronger personal-outdoor PM correlations exist when data are analyzed by individual, over time. However, the degree of this association varies by individual, with some individuals having significant associations and others not. A major deficiency in exposure assessment research, which still persists, relates to the lack of accurate chronic exposure models to be used by epidemiological studies.

### **Progress Made**

The findings from the longitudinal PM exposure studies, described above, were critical to the evolution of our collective research efforts on PM exposure assessment. Results from the Centers research pertaining to PM exposures are presented briefly below, with many of the findings already published, in press or submitted for publication in peer-reviewed journals.

Considerable research was conducted to identify factors that contribute to observed differences between outdoor concentrations of PM and corresponding population exposures. The differences have traditionally been referred to as "exposure error" due to the fact that PM epidemiological studies typically use outdoor PM concentrations as surrogates of exposure. PM Centers exposure research efforts have focused on the following topics: 1) Characterization of spatio-temporal variability of PM components and gaseous co-pollutants measured at centrally-located outdoor sites as a function of site characteristics using the entire U.S. air monitoring network. The models will enable epidemiologists to quantify the effects of "exposure error" on health risk estimates; 2) Assessment of the contribution of outdoor and indoor PM sources on personal exposures. This area of research is critical for determining the relative toxicities of PM of outdoor and indoor origin; 3) Measurement of exposure to specific toxic PM components and gaseous co-pollutants. This information will be of great value to epidemiologists and toxicologists in their efforts to identify the causal agent/s of air pollution-related toxicity.

### **Investigation of the association between outdoor PM concentrations and corresponding personal exposures.**

Ambient PM<sub>2.5</sub> concentrations were shown to be significant predictors of corresponding personal exposures, over time, for a cohort of healthy senior citizens (Figure 1) (Sarnat, et al., 2000). Although the strength of these associations varied by individual and season, the results suggest that for certain individuals, ambient PM<sub>2.5</sub> concentrations are appropriate surrogates of personal PM<sub>2.5</sub> exposures. These findings are consistent with results from recent longitudinal PM exposure studies conducted in Boston (Rojas-Bracho et al., 2000) and the Netherlands (Janssen et al., 1998). When the subject-specific data were aggregated and analyzed together (i.e., cross-sectionally), the association between personal exposures and outdoor concentration was weaker, further highlighting the inadequacy of cross-sectional analytical methods for assessing true personal-ambient PM<sub>2.5</sub> associations for time-series studies.

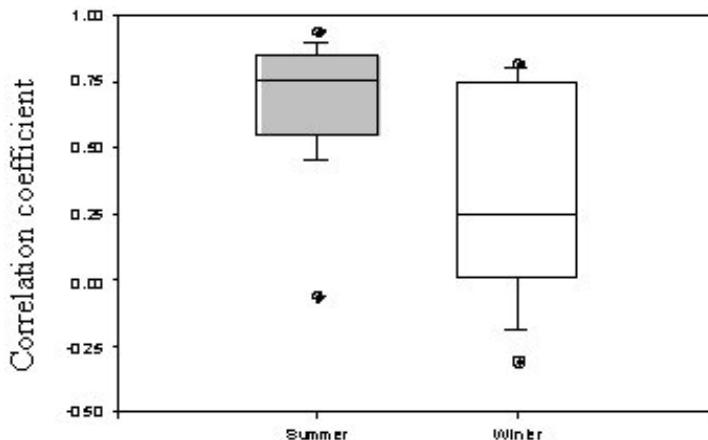


Figure 1. Distribution of subject-specific correlation coefficients: Ambient PM<sub>2.5</sub> concentration versus personal PM<sub>2.5</sub> exposures. Baltimore, MD 1998-99. N = 14 for both sampling seasons

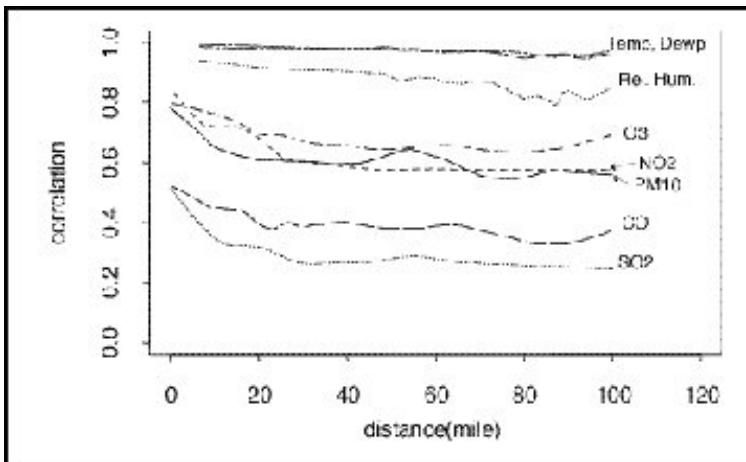


Figure 2. Smoothed Monitor-to-Monitor Temporal Correlation in Seven North-Central Sites.

### Spatial variability of outdoor PM concentrations.

Some of the inter-personal differences in personal-outdoor PM associations may be due to the spatial variability in outdoor PM concentrations. Ito et al. used nationwide PM<sub>10</sub> and gaseous pollutant measurements to examine relationships between concentration measured at various urban and sub-urban sites. Figure 2 shows a smoothed monitor-to-monitor temporal correlation for air pollution and weather variables as a function of distance in seven northern and central U.S. States (Ito et al., 2001). As shown, monitor-to-monitor correlations varied by pollutant. Stronger spatial correlations were found for PM<sub>10</sub>, NO<sub>2</sub> and O<sub>3</sub> as compared to those found for CO and SO<sub>2</sub>. PM<sub>2.5</sub> data will be incorporated within this analysis as it becomes available.

Previous studies in the northeastern U.S. have shown that mean daily PM<sub>2.5</sub> concentrations are reasonably uniform within large eastern U.S. metropolitan areas, such as Washington, DC, Philadelphia, PA and Baltimore, MD. Findings from PM Center-supported studies further indicate that there is relatively little variation in ambient PM<sub>2.5</sub> concentrations between the center of New York City and rural upwind locations (Figure 3). Together, these results suggest that most of the PM<sub>2.5</sub> in the northeastern U.S. originates from distant upwind sources (Thurston et al., manuscript submitted). However, this may not be the case in other locations in the U.S. PM<sub>2.5</sub> mass concentrations in Seattle exhibited modest, yet significant, spatial variability within a radius of 20 km. These differences were associated with both proximity to major highways and the elevation of the monitoring location (Goswami et al., 2001). In Los Angeles, PM<sub>2.5</sub> and PM<sub>10</sub> concentrations measured at various distances from highways (10-1000 meters) showed little spatial variability. However, particle number and black carbon concentrations decreased rapidly with distance from highways (Zhu, et al., 2001) (Figure 4).

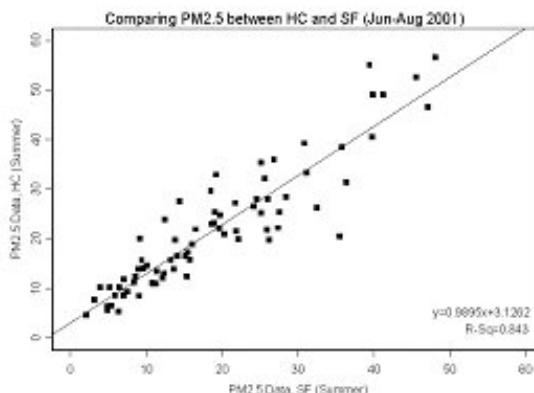


Figure 3. Most NYC summer PM<sub>2.5</sub> mass is explained by upwind PM<sub>2.5</sub>.

#### IMAGE MISSING

Figure 4. Relative PM<sub>2.5</sub> mass (measured by DataRam nephelometer), particle number (measured by CPC), black carbon (BC), and carbon monoxide (CO) concentrations versus downwind distance (Zhu et al., 2001).

The spatial variability of reactive chemical species in PM<sub>2.5</sub>, such as quinones and their precursors in the Los Angeles Basin showed considerable variability from the western end of the Basin to the east, reflecting the direction of the prevailing winds. Although the naphthoquinones decreased from west to east, the concentration of 9,10 phenanthroquinone increased. Since quinones are known to be toxic, their concentrations in PM fractions may be a more sensitive measure of exposure. Levels of quinones in the outlying areas were, as expected, extremely low.

#### **Impact of indoor PM sources on personal exposures.**

As shown in the earlier cross-sectional PM exposure studies, variability in personal-outdoor PM associations is due, in part, to contributions from non-ambient particle sources (Ozkaynak et al., 1996). PM Center-supported longitudinal exposure studies have provided additional evidence of the impact of non-outdoor PM sources for both cohorts of healthy individuals and susceptible sub-populations. Results from Seattle and Baltimore showed that non-ambient PM<sub>2.5</sub> sources contributed 49 and 67% of the total personal PM<sub>2.5</sub> exposures, respectively (Sheppard et al., 2000; Sarnat et al., 2000). In Seattle, the age of the individual significantly influenced the fraction of non-ambient PM contributions to total personal exposures, with greater non-ambient PM contributions observed for children. In Baltimore, indoor ventilation influenced non-ambient PM contributions to personal exposures, where non-ambient PM<sub>2.5</sub> sources contributed 29, 30, and 45% to total personal PM<sub>2.5</sub> exposures for subjects spending their time in well-, moderately-, and poorly-ventilated indoor environments, respectively.

#### **Variability of outdoor PM penetration efficiencies.**

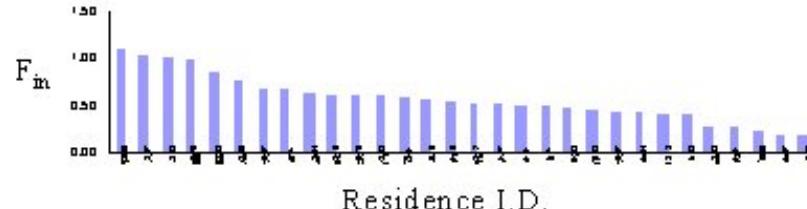


Figure 5. Infiltration fraction ( $F_{in}$ ) of ambient PM to indoor environments at 30 residents in Seattle with 6,571 hourly measurements between 12/99 and 8/00. Values represent 7 - 10 day averages at each residence (error bars = 95% c.i.). The overall mean of  $F_{in}$  for all 30 residences is 0.56.

People spend the majority of their time indoors. Therefore, quantifying the effective penetration efficiencies of outdoor particles into indoor environments is critical for understanding the variability of personal-outdoor PM relationships. Until recently, particle penetration efficiencies were thought to be constant and often assumed to be 100%. As a result, personal/outdoor concentration ratios higher than one were assumed to be indicative of the influence from non-outdoor PM sources. Results from current PM Center exposure studies have shown that particle penetration efficiencies vary substantially by residence type (Sheppard et al., 2001). In Seattle, for example, particle penetration efficiency exhibited significant inter- and intra-home variability. For a total of 30 homes monitored, the estimated mean effective penetration efficiency was  $56 \pm 8\%$  (Figure 5). Since home characteristics, including ventilation, vary by season and locale, these findings may be used to explain some of the heterogeneity in PM-associated risk factors in various epidemiological studies, as reported in the Acute Effects Section.

#### Measurement of personal exposures to specific toxic PM components.

Identifying the specific component/s of outdoor PM responsible for the numerous observed adverse health effects remains an important objective of our exposure assessment research. Results presented in the Biological Mechanisms Section of this report suggest that specific components of outdoor PM, such as transition metals, ultrafine particles and polycyclic aromatic hydrocarbons (PAHs), may be related to allergic airway disease and cardiovascular effects.

Funding has facilitated the development of novel personal multiple pollutant sampling methods that are currently being used in many of the PM Center field studies (Figure 6) (Demokritou et al., 2000). The Multiple Pollutant Personal Sampler provides data on concurrent size- and species-resolved personal PM exposures as well as exposures to numerous gaseous co-pollutants ( $\text{NO}_2$ ,  $\text{O}_3$ ,  $\text{SO}_2$  and numerous volatile organic compounds (VOCs)). To date, the Multiple Pollutant Personal Sampler has been used in the Baltimore, Atlanta, Steubenville and Los Angeles field studies. Other methods are currently under development at the PM Centers to examine exposures to specific PM components.

The PM Centers are conducting a series of studies to identify and quantify specific toxic PM components as well as examine their spatial and temporal distributions. Of particular importance is the role of organic PM constituents, such as quinones, which may play an important role in generating oxidative stress, inflammation and immunomodulating effects in the lungs and airways. Currently, PM seasonal and spatial distributions of outdoor PAH, aldehyde, and quinone concentrations are being characterized for twelve southern California communities participating in the CHS (Cho et al., submitted). Center investigators expect to link spatial inter-community variability of specific organic (i.e. quinones) and carbonyl concentrations with reported respiratory health effects of school children.

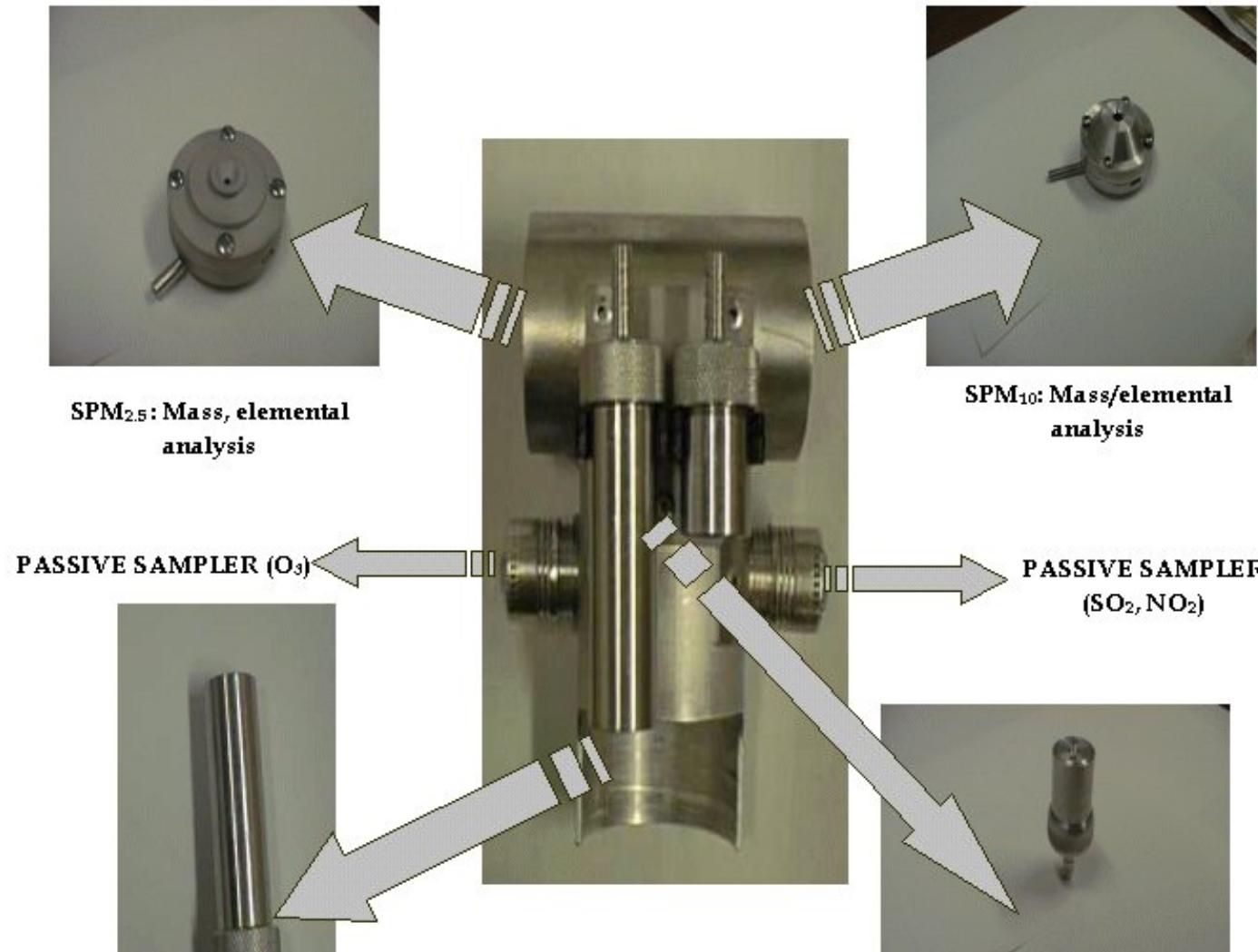


Figure 6. Diagram of the Multi-Pollutant Personal Sampler (Demokritou et al., 2000).

**Measurement of personal exposures to gaseous co-pollutants.**

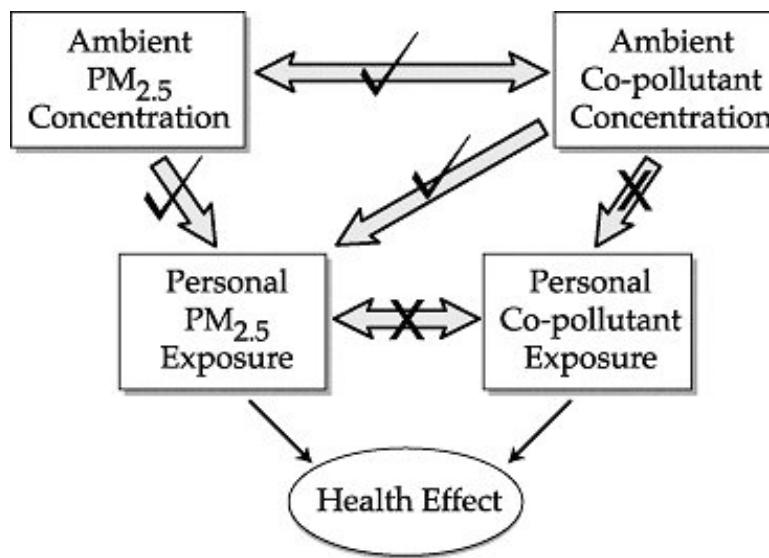


Figure 7. Summary of associations between ambient concentrations and corresponding personal exposures and among pollutant exposures and concentrations in Baltimore, MD (Sarnat et al., 2001). "ü" indicates strong correlations; "x" indicates weak correlations.

Ambient concentrations of PM and its gaseous co-pollutants are frequently correlated, making it difficult for epidemiological investigations to determine whether observed PM-health effect associations are confounded by these gaseous co-pollutants. The role of gaseous co-pollutants as potential confounders or surrogates of personal PM<sub>2.5</sub> exposures was investigated for cohorts of healthy senior citizens, children and individuals with COPD living in Baltimore, MD (Sarnat et al., 2001). Investigators used the Multiple-Pollutant Personal Sampler, which allowed for associations between personal particulate and gaseous exposures to be examined directly. Consistent with results from previous monitoring studies, strong correlations existed between ambient PM<sub>2.5</sub> and ambient gaseous co-pollutant concentrations (i.e., O<sub>3</sub>, NO<sub>2</sub>) (Figure 7). In contrast, weak correlations were found between personal PM<sub>2.5</sub> and ambient gaseous co-pollutant exposures, suggesting that the gaseous co-pollutants are unlikely confounders of PM<sub>2.5</sub>. Finally, strong correlations between personal exposures to PM<sub>2.5</sub> and ambient concentrations of the co-pollutants existed, indicating that the gaseous co-pollutants may serve as appropriate surrogates of personal PM<sub>2.5</sub> exposures.

### Short-Term Goals

Exposure studies conducted to date have provided a solid basis for future research. During the next two-to-three years, the PM Centers will: 1) complete exposure studies currently being conducted in St. Louis, Los Angeles, Steubenville and Seattle. These additional datasets will enable us to further characterize personal PM exposures in locations with diverse study populations, meteorological and air quality conditions. Of particular importance are potential differences in exposures among susceptible sub-populations. To date, cohort-specific differences in PM exposures have not been examined due to sample size limitations; 2) examine associations between personal exposures to PM and its gaseous co-pollutants in various locations throughout the U.S. Results from Baltimore provide important initial information concerning the role of gaseous pollutants as confounders and/or surrogates of PM. Exposure data from studies in Los Angeles, Atlanta, Steubenville and St. Louis will enable us to examine these relationships in additional urban environments; 3) continue the characterization of short-term (24-hour) PM exposures and identify factors that influence their relationship to outdoor concentrations. This information will assist in creating models of short-term personal exposures to be used in estimating chronic exposures to PM; 4) collect data on outdoor PM concentrations and personal exposures to specific PM components such as metals, PAHs, elemental and organic carbon, sulfate and nitrate as part of our ongoing field studies. In addition, efforts will continue to expand the range of personal exposure measurements,

including ultrafine particles and carbon monoxide; 5) determine concentrations of quinones, carbonyls and PAHs in ambient air samples at selected sites in the Los Angeles Basin. The objective is to provide quantitative chemical data on specific chemical entities relevant to human health and to the development of a model for atmospheric changes in the chemical constituents of air pollution; 6) continue data analyses for the investigation of "exposure error" using air pollution data from 1985-2000 for the entire U.S. More detailed characterization and comparison of PM<sub>10</sub> and PM<sub>2.5</sub> data will be conducted in areas with multiple monitors; 7) continue collection of outdoor PM samples to be used in toxicological studies of fine and ultrafine ambient particles. Initial studies to examine the hypothesis that freshly generated fine plus ultrafine emissions from a freeway with heavy diesel traffic increases the severity of asthma and inflammatory responses in a sensitive animal model are under way; and 8) validate and refine models of local within-community exposures based on already available data sets on traffic patterns in metropolitan areas, and further assessment of the chemical composition of traffic associated particulate exposures.

### **Long-Term Goals**

The PM Centers' long-term goals involving exposure assessment include: 1) the development of chronic PM exposures models. Chronic exposure models will be based on relevant advances in short-term exposure models, re-examinations of historical and newly generated data on air pollution composition and levels, time-activity information, and indirect measures of PM exposure, such as co-varying gaseous pollutant concentrations, Geographical Information System data and housing characteristics may also be used as input data for these chronic exposure models. Individual or population estimates of long-term exposures will be used by epidemiological studies to assess chronic health effects. Of particular importance will be the development of chronic exposure models for specific toxic components of PM; 2) development and validation of source apportionment techniques to link health outcomes with specific PM source types. The NYU PM Center, in collaboration with colleagues at the other PM Centers and at EPA, will host a Source Apportionment Workshop in the Spring of 2002 to standardize source-apportionment methodologies for PM epidemiological studies; and 3) development of new and more sensitive biomarkers of PM exposure. This will enable us to assess human exposures for prospective population studies in a timely and cost-effective manner.

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## Science Topics: Particulate Matter: Solicitations

### Background

#### Solicitations

- [What are some basic questions that we are trying to answer](#)
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**What are some basic questions that we are trying to answer through our solicitations:**

NCER's main PM research areas and the associated research questions that we hope to answer are:

1) Toxicology: Which constituents or properties of PM are most responsible for human health effects? Through what biological mechanisms do these effects occur?

2) Dosimetry and Modeling: How does the amount of particulate matter deposited in the lungs of exposed individuals vary among members of the general population and susceptible subpopulations?

3) Exposure: What is the relationship between personal exposures to PM and ambient measurements? How can we improve assessments of exposures in normal human populations and in sensitive populations (i.e., the elderly, individuals with respiratory or cardiovascular disease, and children)?

4) Epidemiology: Which groups are particularly susceptible to health effects from PM exposure? What are the effects of long-term exposures to particle constituents, including ultrafine particles? What is the influence of gaseous co-pollutants on effects of long-term exposure to PM?



### **What is the current focus of our research?**

NCER's current principal areas of PM research include:

- Health effects research/mechanisms of injury: identifying the biological mechanisms of injury of the combined effects of PM and co-pollutants; expanding from an initial focus on pulmonary effects to broader systemic effects including an emphasis on cardiovascular mechanisms of PM health effects.
- Health Effects Research/epidemiological studies: understanding the morbidity and mortality

5) Implementation: What are the characteristics of PM emitted from primary sources in the U.S. and what are the emissions of reactive gases leading to secondary particle formation? What is the relationship between emission sources and ambient concentrations of biologically important constituents of PM?

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**NCER's current 2002 PM program includes two directed solicitations and one indirect solicitation:**

- \* [Epidemiologic Research On Health Effects Of Long-Term Exposure To Ambient Particulate Matter and Other Air Pollutants](#)

This RFA covers two types of PM research:(1) retrospective epidemiologic studies that make use of currently available information on health and air quality; (2) methods/model development studies relating to future, prospective epidemiologic research.

- \* [Airborne Particulate Matter Health Effects: Cardiovascular Mechanisms](#)

This RFA calls for research on cardiovascular mechanisms of particulate matter health effects and attempts to answer the following questions:

1. What are the underlying mechanisms that can explain the epidemiological findings of mortality/morbidity associated with exposure to ambient PM?
2. What subpopulations are at increased risk of adverse health outcomes from particulate matter?

The RFA covers several types of studies including:

- Mechanisms of Pathogenesis: Humans and/or Laboratory Animals incuding electrical activity of the

attributable to long-term PM exposures, taking into account simultaneous exposures to other air pollutants.

- Research in support of the PM NAAQS: including modeling, chemistry, emission and measurement requirements necessary for the successful implementation of the PM NAAQS

### **Particulate Matter Centers**

The five centers established in June 1999 will advance the understanding of PM health effects, how they occur, and improve understanding of populations who are susceptible to health effects from exposure. The PM Research Centers are a central component of EPA's on-going integrated research program for PM which also includes ORD's intramural research program, interagency research and other STAR Program RFAs for individual research grants. The centers will advance scientific understanding of the health effects of PM in the following priority areas:

- Exposure: Improve assessments of personal exposures to PM in normal human populations and in sensitive populations (i.e., the elderly, individuals with respiratory or cardiovascular disease, and children).
- Dosimetry and Modeling: Develop new models regarding the amount of particulate matter

heart, processes which damage cardiac cells, cause endothelial cell dysfunction, or alterations in blood viscosity or clotting.

- Models of Susceptibility: use animal models of cardiovascular disease to study the effects of PM, especially newer genetic models that target specific cellular pathways.
- Controlled Exposure Studies in Humans or Animals: demonstrate how inhaled PM directly affects the heart (e.g., through uptake of particles into the circulatory system or through release of soluble substances into the circulatory system) or whether and how PM affects autonomic control of the heart and cardiovascular system.
- Impact of Global Change on Air Quality for Tropospheric Ozone and Particulate Matter  
<http://es.epa.gov/ncer/rfa/>.
- [Exploratory/Futures Research](#) - Opens July 2002

In this RFA EPA engages the scientific community in identifying and applying new knowledge, approaches, and techniques in novel ways to solve the emerging environmental problems of the future. Although not specifically targeted PM projects will be considered under this RFA.

**What were the areas of emphasis in the NCER's past PM and related research solicitations?**

1995 Air Toxics - [???](#)

[1996 Research Grants for Ecological Assessment: Air Quality](#)

This RFA covered a number of air quality issues including air toxics. The questions posed by the RFA included:

- Are there public health risks that result from a) exposures to recurrent acute exposures from both point and area sources, b) chronic exposures from individual facilities or the combined exposures from multiple facilities, and c) mixtures which impact the same or different organ

deposited in the lungs of exposed individuals. This is critical in understanding the relationships between individual exposure and health responses of sensitive populations.

- Toxicology: Identify which constituents or properties of PM are most responsible for human health effects and how these effects occur. Reducing uncertainty in this area is important for human health risk assessment.
- Epidemiology: Improve understanding of which groups are particularly susceptible to health effects from PM exposure.

systems?

- Can susceptible subpopulations be identified that are at increased risk due to higher exposures or biological sensitivities?
- What are the emissions of air toxic pollutants from sources of concern in urban areas? The RFA requested projects that used multi disciplinary approaches to investigate source identification and characterization, exposure characterization (modeling/monitoring), and characterization of health outcomes as related to exposure. Eleven projects funded under this RFA were dealing with PM.

#### 1997 Ambient Air

This RFA covered research to support the North American Research Strategy for Tropospheric Ozone (NARSTO), a public/private sector cooperative 10-year research effort to both improve the technical understanding of the tropospheric ozone issue and support future evaluations and adjustments to attainment strategies.

The EPA/ORD contribution to the NARSTO program emphasized the areas of atmospheric chemistry and modeling, ambient measurement methods, and emissions research. The RFA acknowledged the overlap of research needs for PM and tropospheric ozone and called for exploration of the most important unknowns in tropospheric ozone chemistry: atmospheric oxidation reactions which also play an important role in aerosol formation and modeling the transport and fate of both ozone and particulates.

#### 1997 Health Effects and Exposures to Particulate Matter and Associated Air Pollutants

This RFA was NCER's first RFA dedicated solely to PM health effects research. The RFA called for research projects in the following areas:

- Causal mechanisms of PM toxicity including clinical, epidemiological, toxicological, and in vitro research for pulmonary, cardiovascular, and immunological effects.
- Dose-response relationships for PM toxicity.
- Reducing uncertainties in exposure assessment for PM and associated copollutants.
- Characterization of individual and population exposures to PM

(concentration, size, composition, fine mode versus coarse mode, etc.) and copollutants, including relationships between personal exposure to ambient PM, indoor PM, and total PM.

- New epidemiological studies to better define relationships between exposure to PM and other atmospheric constituents and adverse health effects.
- The composition of little understood components of PM such as organic compounds (non-volatile and semi-volatile), primary biological materials, and species dissolved in liquid particles.

#### 1998 Air Pollution Chemistry and Physics

This RFA covered research to support the North American Research Strategy for Tropospheric Ozone (NARSTO), a public/private sector cooperative 10-year research effort to both improve the technical understanding of the tropospheric ozone issue and support future evaluations and adjustments to attainment strategies.

The EPA/ORD contribution to the NARSTO program emphasized the areas of atmospheric chemistry and modeling, ambient measurement methods, and emissions research. Areas specifically related to PM covered by this RFA included atmospheric chemistry; modeling; and ambient measurement and analysis methods.

#### 1998 Health Effects and Exposures to Particulate Matter and Associated Air Pollutants

This RFA dedicated to PM research covered health effects research areas including: chronic epidemiologic studies with special interest on studies using existing cohorts; mechanisms of PM toxicity including chronic effects of PM exposure and the relationship between acute and chronic biological responses; and dose response relationships for PM toxicity; and studies on the magnitude and variability of the errors in the assessment of exposure due to measurement error.

#### 1999 Airborne Particulate Matter (PM) Centers

This RFA solicited proposals to develop PM research centers with well-defined and integrated programs that address PM research needs in the areas of exposure, dosimetry and extrapolation modeling,

toxicology, and epidemiology. This RFA was in response to requests by Congress and recommendations of the NRC. (See [Background](#) for more detail)

#### [1999 Airborne Particulate Matter Health Effects](#)

This RFA covers research in the following areas: Assessment of Hazardous PM Components; Combined Effects of PM and Gaseous Copollutants; and Mechanisms of Injury. This RFA detailed many research needs including: evaluating 11 plausible PM causative constituents and properties were listed at the EPA/NARSTO PM workshop held in Chapel Hill, NC on July 22-23, 1998; determining the role of PM chemistry and biological characteristics in toxicological responses to PM that relate to epidemiological health outcomes; understanding the potential for PM independently and in combination with other pollutants to affect the deposition, target tissue dose, and response of the lung and related systems; developing and evaluating novel hypotheses on the mechanistic basis of PM toxicity from the molecular through physiologic levels; and identification of the neurologic, systemic, and direct cardiac responses to PM.

#### [2001 Airborne Particulate Matter Health Effects](#)

This RFA covers two primary PM research areas: combined effects of PM and gaseous copollutants and mechanisms of injury. This RFA specifically calls for research projects on:

- Understanding the potential for PM deposition, target tissue dose, and effects on the lung and related systems in response to PM independently and in combination with other pollutants.
- Understanding the role of PM independently and in combination with other pollutants in epidemiological findings associating PM exposures with health outcomes.
- Identifying the molecular and physiological mechanisms by which ambient air PM mediates adverse health effects;
- Identifying non-pulmonary effects of PM such as cardiac, neurologic, immunologic, etc., and to understand the mechanisms associated with these effects;
- Identifying potential health conditions, such as conditions

related to cardiac or immune system status, that would enhance susceptibility to adverse PM health effects and the biological mechanisms by which host susceptibility factors influence the dose response relationship.

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### **PM Centers**



#### **Harvard Particulate Center**

The Harvard Particulate Center will address key scientific issues regarding the health effects of ambient particles. The specific aims of the Center reflect eight of the National Research Council's ten highest research priorities for ambient particle research. To meet these objectives, the Center will focus on three research themes: exposure, susceptibility, and biological mechanisms/dosimetry. By building the Center around these three defined research themes, the Center will remain focused while maintaining an integrated and inter-disciplinary research approach, both of which will be critical to our ability to address key particulate health effect issues in a timely manner. Each of our three research themes will include projects that span several disciplines and that draw from the expertise and experience of our Center investigators.

### [Research Projects](#)

#### **Northwest Research Center for Particulate Air Pollution and Health**



### **PM Centers**

In May 1998, EPA's STAR Program issued a request for applications (RFA) for research grant proposals to establish five PM Centers following the recommendations from the National Research Council report, *Research Priorities for Airborne Particulate Matter: 1 Immediate Priorities and Long-Range Research Portfolio*, and direction from Congress in the Environmental Protection Agency's (EPA's) 1998 appropriation. The five centers established in June 1999, were selected from 22 applicants after a merit review by a panel of external scientific experts. These centers will advance the

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for Particulate Matter and Health is one of five centers around the country funded by the US Environmental Protection Agency to study the effects on human health of particulate air pollution. It is important to estimate these effects accurately. On one hand they could add up to a significant public health burden. On the other hand reductions in particulate pollution beyond what is necessary for public safety could have serious economic impacts. Our planned research, together with that of other groups around the world, will contribute to decisions about air quality standards and to the understanding of how we are affected by the air we breathe.

[Research Projects](#)**NYU School of Medicine PM Center**

The overall objective of this Center is to develop and conduct a comprehensive research program focused on the identification and characterization of the physical and chemical properties of particulate matter (PM) that adversely impact human health. The focal hypothesis of this PM Center is that specific chemical species within PM and within certain particle size ranges are primarily responsible for PM's mortality, morbidity, and functional effects.

[Research Projects](#)**Rochester PM Center**

The US Environmental Protection Agency has awarded the University of Rochester a STAR ("Science To Achieve Results") Center grant (R827354). It provides support for one of five such centers established to study the role of airborne particulate matter, especially ultrafine particles, in causing health problems. A multidisciplinary team of experienced investigators are testing the hypothesis that ultrafine particles occurring in the urban atmosphere cause adverse health effects.

[Research Projects](#)

understanding of PM health effects, how they occur, and improve understanding of populations who are susceptible to health effects from exposure.

The PM Research Centers are a central component of EPA's on-going integrated research program for PM which also includes ORD's intramural research program, interagency research and other STAR Program RFAs for individual research grants. The centers will advance scientific understanding of the health effects of PM in the following priority areas:

**Exposure:** Improve assessments of personal exposures to PM in normal human populations and in sensitive populations (i.e., the elderly, individuals with respiratory or cardiovascular disease, and children).

**Dosimetry and Modeling:** Develop new models regarding the amount of particulate matter deposited in the lungs of exposed individuals. This is critical in understanding the relationships between individual exposure and health responses of sensitive populations.

**Toxicology:** Identify which constituents or properties of PM are most responsible for human health effects and how these effects occur. Reducing uncertainty in this area is important for human health



Southern

risk assessment.

**Epidemiology:**

Improve understanding of which groups are particularly susceptible to health effects from PM exposure.

**California Center for Airborne Particulate Matter**

The overall objective of the Southern California Center for Airborne Particulate Matter (SCCAPM) is to bring together outstanding scientists from the leading universities in Southern California to identify and conduct high priority research to better understand the effects of particulate matter (PM) and ensure protection of public health. The SCCAPM makes use of an integrated approach to address each of the areas of Exposure, Dosimetry, Toxicology, and Epidemiology. This integration is accomplished by seeking out and involving in the Center some of the major figures in air quality and environmental health. A team has been assembled for SCCAPM that is committed to the need for strong cross- and interdisciplinary programs of research in order to address the challenging issues posed by PM. By improving our fundamental and observational understanding of the complex relation between particle exposure and human health, it is our goal to lay a firm scientific foundation for effective intervention strategies for public health protection.

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### **Results Used by EPA and Others**

EPA, state and local governments, and other researchers use Particulate Matter research results conducted by many STAR grantees.

- [PM Monitoring](#)
- [Susceptibility](#)
- [Epidemiology](#)
- [Biological mechanisms of PM toxicity](#)
- [PM Centers](#)



### **PM Monitoring (Individual STAR Grants):**

- Ion and liquid chromatography are two of most widely used techniques in environmental analysis, but had been relegated to laboratory use due to lack of portable and robust equipment. This STAR grant supported development of capillary liquid and ion chromatographs that are easily portable and useable in the field. The system preserves the gases of nitric acid and ammonium, unlike other methods. This method is now used in major field measurement campaigns including the Supersites Program in Nashville, Atlanta, and Houston as well as in the Philadelphia NEOPS



study and BRACE study in Tampa.

Real Time Gas/Aerosol Analyzers  
(Sandy Dasgupta - Texas Tech  
Univ.)  
Grant R825344

[Original Abstract](#)

[1999 Progress Report](#)

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- This STAR grant supported development of a new instrument called a Single Particle Mass Spectrometer for on-line compositional analysis of individual ultrafine particles (from 10nm to 1micron) as well as the development of software to operate the instrument for extended periods. This instrument and software are now being used in the EPA Supersites program in Atlanta, Houston, Pittsburgh and Baltimore.

Real-Time Measurement of the Size and Composition of Atmospheric Particulate Matter  
(Tony Wexler - University of Delaware)  
R826234

[Original Abstract](#)

[1997 Progress Report](#)

- Methods were evaluated under this project to speciate volatile and reacting compounds in single particles by on-line laser desorption ionization mass spectrometry. The study resulted in improved understanding of relationship between particle composition and laser desorption ionization mass spectra allowing practical recommendations to be made prior to analysis (e.g., ambient measurements in humid environments require water to be removed from particles prior to analysis by laser desorption ionization)

Speciation of Volatile and Reacting Compounds in PM (Murray Johnston - University of Delaware)  
Grant R823980

[Original Abstract](#)

[Final Report](#)

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### Susceptibility (Individual STAR

**Grants):**

- This project has resulted in one of the first reports linking coarse particles to affects on heart rate variability. The study involved 20 elderly patients with coronary artery disease in Coachella Valley, CA, an area dominated by coarse fraction PM. The participants were checked using 24 hour EKG monitoring once/week for up to 12 weeks. The exposure assessment consisted of real time monitoring PM10, 2.5, ozone, nitrogen dioxide and CO at two fixed site monitors. Preliminary results suggest that PM10, 2.5 and the coarse fraction were all associated with small decrements in HRV; none of the gases were associated with changes in HRV

Relationship of Ambient PM to Heart Rate Variability and Cardiac arrhythmias in Elderly with Coronary Artery Disease (Ostro - Cal EPA)  
Grant R826783

[Original Abstract](#)  
[2000 Progress Report](#)

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**Epidemiology (Individual STAR Grants):**

- This STAR grantee is adding the air pollution component to a major NIH-funded study of cardiovascular and pulmonary diseases in 15,000+ men and women followed from 1987 - 1998 (ARIC cohort). Early results indicate that higher levels of blood inflammatory markers are associated with higher PM10, especially among persons with a history of cardiovascular disease.

Cardiovascular responses to PM  
(Liao, Penn State)  
Grant R827994

[Original Abstract](#)  
[2000 Progress Report](#)

- This project involved the association of fine particulate matter from different sources with daily mortality in six U.S. cities.  
(This needs serious beef up to be able to use)

Laden F, Neas LM, Dockery DW,  
Schwartz J.  
Grant R82\_\_\_\_\_

Original Abstract  
Progress Report  
Final Report

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**Biological mechanisms of PM toxicity  
(Individual STAR Grants):**

- This research entails exposing rats to concentrated air particles in Fresno, and examining effects on airway epithelial cells. The preliminary results indicate that PM exposure was associated with a significant reduction in the viability of lung cells. The sampling in this study was performed in conjunction with the EPA Supersite program using a particle concentrator from the Southern California PM Center.

Mechanisms of PM toxicity in the lungs of rodents (Pinkerton, UC Davis)

Grant R82\_\_\_\_\_

Original Abstract  
Progress Report  
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- Gordon has run a series of studies exposing rodents to concentrated airborne particles, using EPA/NHEERL software to analyze arrhythmias. Early results indicate that the exposures are associated with increased heart rate in hypertensive rats, and increased arrhythmias in aged rats.

Stress response in rodents (Gordon, NYU)

Grant R82\_\_\_\_\_

Original Abstract  
Progress Report  
Final Report

- This study compared healthy and sick animals response to actual urban air particulate.

The grantee observed pulmonary inflammation in rodents with chronic bronchitis exposed to CAPS. The study provided evidence for the hypothesis that individuals with pre-existing cardiopulmonary disease are more susceptible to PM effects.  
Godleski (with Clarke)

Grant R82\_\_\_\_\_

Original Abstract  
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### **PM Centers - Progress Made on Understanding Health Effects**

- Harvesting - This study has early results which indicate that the effects observed in daily time series studies are not due primarily to short-term mortality displacement. The investigators have found similar results for hospital admissions data.

**This needs more detail - which center - more specifics on study etc**

- Confounding - Several Harvard Center studies showed that there is no significant unaddressed confounding by other criteria pollutants, PM of indoor origin, or season. Harvard researchers have also determined through Season-specific analyses that mortality was predominantly associated with PM2.5 and not SO2.

**This needs better clarification**

- Harvard researchers in several single-city studies found that the risk of PM-associated hospital admissions for heart disease for diabetics was double that for the general population. Also, diabetics found to have an increased risk of PM-associated mortality.

**Needs more detail**

### **Contributions Made by the PM Centers as Noted by the SAB:**

- In a recent evaluation of the PM Center Program the SAB found that program has already produced some findings of policy significance. For example, the addition of work from the Centers to other studies suggests the absence of a threshold for PM effects, a finding which raises an important policy issue. Another important observation is the suggestion by the Rochester Center that ultrafine PM has effects distinct from those attributable to PM10 and/or PM2.5. Also, preliminary findings from the Centers support or expand upon

previous findings that motor vehicle emissions appear to contribute significantly to PM health effects, that NO<sub>x</sub> levels are associated with lung function changes in children, and that the organic portion of PM may be responsible for some of the PM effects. Such information raises some key policy and controls-related questions, such as how to reduce exposure to the most toxic PM fractions.

- As a result of specific Center needs, there have been initial developments of new sampling techniques and extensive integration of state-of-the-art existing measurement techniques in epidemiological, toxicological, and exposure investigations. Examples of new methods and their immediate and extensive use in Centers research are the use of the multi-pollutant personal sampler in several of the panel studies, the development of the ultrafine particle concentrator, the development of new methods to measure methoxyphenols as markers of wood smoke combustion, and the development of a new personal sampling method for temperature-resolved carbon fractions.
- The Centers, through a series of animal and human clinical experiments, have been effective in evaluating hypotheses related to inflammation and immunity and cardiovascular effects due to exposure to PM at ambient levels. The inflammation pathway has been linked to both acute and chronic effects. In order to test and evaluate the validity of observed results, multiple Centers collaborated, through controlled interactive experiments and shared protocols, in testing, for example, the effects of different particle size fractions and conducting inter-species comparisons. They have also begun addressing factors of susceptibility, such as aging. The outcome of this research has been a remarkable consistency and continuity in the observed effects that appears to lead to unified hypotheses on mechanisms and pathways. This weight-of-evidence and the need for internal

consistency in understanding the observed effects is possibly the most significant contribution of the PM Centers.

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**Interim Review of the Particulate Matter (PM) Research Centers of the USEPA: An SAB Report**

**A review of the PM Research Centers Interim Review Panel of the Executive Committee of the USEPA Science Advisory Board (SAB)**

The following information and excerpts are from an EPA Science Advisory Board draft document that has been released to the public and is available on EPA's web site at:

<http://www.epa.gov/science1/ecpmo2ooxdft319.pdf>

This draft material is being released at this time for general information to members of the interested public and to EPA staff. This action is consistent with the SAB policy of releasing draft materials only when the Committee involved is comfortable that the document is sufficiently complete to provide useful information to the reader. The reader should remember that this is an unapproved working draft and that the document should not be used to represent official EPA or SAB views or advice. Draft documents at this stage of the process often undergo significant revisions before the final version is approved and published



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**Conclusions:**

1. The PM Centers Program has both a produced benefits beyond those normally found in individual investigator-initiated

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grants and b) is likely to continue to provide such benefits through to the end of its current funding cycle. Overall, the Panel found that the program merits continuation beyond FY04 -- through a new fully- competitive round of applications -- as one part of a diverse PM research portfolio at the Agency.

2. The Panel identified several specific advantages that the Centers approach offers over other traditional research mechanisms, including enhanced flexibility and adaptability leading to improved timeliness, ability to conduct higher-risk pilot and validation efforts, study designs enhanced by intra-center multi-disciplinary integration, and improved leveraging of the Agency's and the Centers= research resources, among others.
3. The Panel identified several ways in which a new round of Center grants could be enhanced, either by expanding upon activities already underway or by undertaking new efforts. Importantly, the Panel noted that while there are evident benefits of integration within and across Centers, there are also challenges to insure that the work of the Centers does not become isolated from that of other researchers within the Agency and in the academic community. Key enhancements include the following: a. Continued attention in a new request for applications (RFA) to focusing the Centers' efforts on the most critical PM needs b. The development of an informal, but overarching, mechanism of scientific advice to the program c. Enhanced opportunities for cross-fertilization of ideas with EPA intramural researchers and the broader extramural community d. The provision of systems and resources from the start for inter-center integration efforts.

The SAB concluded that the PM Centers Program has both a) produced benefits beyond those normally found in individual investigator-initiated grants and b) is likely to continue to provide such benefits through to the end of its current funding cycle. Overall, the Panel found that the program merits continuation beyond FY04 -- through a new fully-competitive round of applications -- as one part of a diverse PM research portfolio at the Agency.

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**SAB Summary Letter to the Administrator**

(from draft Interim Review of the Particulate Matter (PM) Research Centers of the USEPA: An SAB Report):

Honorable Christine Todd Whitman  
Administrator  
U.S. Environmental Protection Agency  
1200 Pennsylvania Avenue,  
NW Washington, DC 20460

Subject: Interim Review of the Particulate Matter (PM) Research Centers: An SAB Report

Dear Governor Whitman:

On February 11 and 12, 2002 the PM Centers Interim Review Panel (Panel) of the US EPA Science Advisory Board (SAB) met to review the Agency's PM Research Centers program as a

mechanism for generating research results that can inform Agency decision-making. The request to provide this advice was received from the National Center for Environmental Research (NCER) in the Office of Research and Development (ORD).

In 1998 the NCER, under its Science to Achieve Results (STAR) Program issued a competitive request for applications that resulted in the support of five PM Research Centers for up to five years, with a total of \$8M expended in the first year of the program. The Centers were to address research needs in the areas of exposure, dosimetry, extrapolation modeling, toxicology, and epidemiology.

As it considers budget formation for FY04 and beyond, NCER needs to decide whether or not to continue with the concept of PM Research Centers beyond the current funding cycle, or whether there might be a better way of generating the research results that will inform Agency decision-making on PM issues. Insufficient time has passed for the Centers B individually or collectively B to have generated a body of research results that could allow a definitive answer to this question based on "outputs", per se. However, considerable experience has been gained with the Centers concept to date that can allow an assessment of the overall utility of this approach, if not of the individual Centers themselves.

This emphasis on the assessment of concept of Centers-based research is reflected in the Charge to the Panel that consists of an overall questions, plus six specific questions:

**Overall Question:** Is it likely that the PM Centers program will be sufficiently successful to merit continuation in FY 2004 and beyond? In which areas, to what extent, and for what reasons is a PM Centers program beneficial? Where it is not, what improvements can be made?

**Specific Questions:**

1. Recognizing the PM Centers program is barely at its halfway point, what important research findings (or promising investigations) have been made that would not have occurred otherwise? What unique aspect(s) of a Centers program enabled such actions to be taken.
2. To what extent has the direction or focus of research shifted as a result of the multi-disciplinary interactions within the Center (i.e., findings in one department influence researchers in another to change direction or emphasis). To what extent have changes in research direction or emphasis been influenced by Science Advisory Committee reviews, interactions with other PM Centers, or interactions with the broader PM research community? Which factors have been most influential?

3. How successful are Centers in communicating their findings to the public and specifically, to those who directly use their research? Is it clear that the work has been supported by the PM Centers program?
4. How, if at all, does a PM research centers program facilitate agreement or consensus on protocols or procedures to enable more direct comparison of results among research institutions or centers?
5. How, if at all, does a PM research centers program leverage or maximize use of resources through sharing expensive equipment, samples, data, etc.?
6. How is the program perceived within and outside the research community? Does a research center have greater visibility, and if so, what is the impact?

Detailed answers to these questions are found in the body of the report. The thrust of the answers are capture in the major findings and recommendations:

1. The PM Centers Program has both a) produced benefits beyond those normally found in individual investigator-initiated grants and b) is likely to continue to provide such benefits through to the end of its current funding cycle. Overall, the Panel found that the program merits continuation beyond FY04 -- through a new fully- competitive round of applications -- as one part of a diverse PM research portfolio at the Agency.
2. The Panel identified several specific advantages that the Centers approach offers over other traditional research mechanisms, including enhanced flexibility and adaptability leading to improved timeliness, ability to conduct higher-risk pilot and validation efforts, study designs enhanced by intra-center multi-disciplinary integration, and improved leveraging of the Agency's and the Centers= research resources, among others.
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program c. Enhanced opportunities for cross-fertilization of ideas with EPA intramural researchers and the broader extramural community d. The provision of systems and resources from the start for inter-center integration efforts.

We appreciate the opportunity to review and provide advice on the PM Research Centers program. We want to acknowledge the valuable assistance of the Agency staff who supplied us with information that is a part of the public record of our meeting. The presentations and availability of the Center Directors to answer questions during our public meeting was also quite helpful.

We look forward to your response to this report.

Sincerely,

Dr. William H. Glaze,  
Chair Mr. Daniel Greenbaum,  
Chair Executive Committee PM Research Centers  
Interim Review Panel  
Science Advisory Board Executive Committee  
Science Advisory Board

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**The EPA's Particulate Matter (PM)  
Health Effects Research Centers Program**  
A Mid-Course (2 1/2 year) Report of Status,  
Progress, and Plans  
Prepared for: Public Review by EPA's Science  
Advisory Board (SAB) by the PM Centers

<http://es.epa.gov/ncer/centers/airpm/sab/report.html>

The PM Centers, in their first two and a half years, have initiated research directed at the specific critical issues identified by the NRC Committee, and have also initiated collaborative activities including sponsorship of Scientific Workshops to further research in key areas, such as characterizing respiratory and cardiovascular health effects associated with PM exposures, assessing costs and health benefits of air pollution controls, examining the health impacts of gasoline emissions, and developing methods for apportioning PM sources.

Through their individual and collective activities during the initial years of the PM Centers, considerable progress has been made towards understanding ambient air PM health effects and addressing areas of remaining scientific uncertainty. Future research activities at the PM Centers will include both epidemiological and inhalation studies to enhance our understanding of the health effects of PM, with an increasing focus on long-term effects associated with chronic PM exposures. These goals are consistent with EPA's Multiyear Plan for PM research as defined in its November 2001 presentation to the NRC Oversight Committee.

This report provides a synopsis of the research

accomplishments to date, short-term goals (during the two and a half remaining years of Center support) and long-term goals (beyond initial 5 years of Center support) for the PM Health Effects Centers. This report consists of six sections. Sections 1-5 address issues relating to:

1. [Biological Mechanisms](#);
2. [Acute Effects](#);
3. [Chronic Effects](#);
4. [Dosimetry](#);
5. [Exposure Assessment](#);

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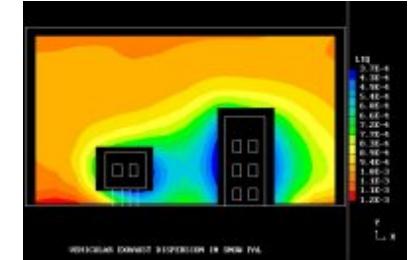
### NCER Publications

### Other Related NCER Research

- [The Lovelace Respiratory Institute](#)
- [Health Effects Institute](#)
- [Environmental Lung Disease Center National Jewish Medical and Research Center](#)
- [Mickey Leland National Urban Air Toxics Research](#)

### Other Related NCER Research

In addition to the PM Centers specifically established for PM research, NCER supports other PM research occurring at many of its STAR and Targeted (line item) centers established with more expansive research goals. These include the Lovelace Respiratory Institute, the Health Effects Institute, the Environmental Lung Disease Center, and several of the STAR Centers of Excellence in Children's Environmental Health and Disease Prevention Research.



### The Lovelace Respiratory Institute



#### [The Lovelace Respiratory Research Institute](#)

[Institute](#) [\[Exit disclaimer\]](#)  
is a private biomedical research institute

dedicated to the reduction of the nation's substantial respiratory health burden. The center aims to cure of respiratory diseases through research aimed at understanding their causes and biological mechanisms, eliminating exposures to causal agents, and developing improved treatments. It is one of the nation's largest independent, non-profit biomedical research organizations, and the nation's only such organization wholly dedicated to basic research on respiratory health problems. The Institute readily opens its unique

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research facilities to university, government and private collaborators. NCER supports the LRRI as a Congressional line item targetted research center. Some LRRI's of the ongoing PM related research projects are listed below:

[National Environmental Respiratory Center/Lovelace Respiratory Research Institute](#)

[\[EXIT disclaimer >\]](#)

The NERC's principal activity is to conduct a series of studies aimed at determining the contributions of pollution mixture constituents to the respiratory health effects of pollutant mixtures.

The initial multi-year set of studies will employ a consistent set of respiratory health assays to determine the effects of several complex, real-world, man-made air pollution mixtures. The exposure atmospheres were selected so that their similarities and differences can be used as tools to determine the roles of individual constituents, families of constituents, and combinations of constituents in causing the various health effects of the total mixture. The recommended matrix of 12 mixtures will include diesel (old and new technology) and gasoline (on-road catalyst and off-road non-catalyst) engine exhaust, wood smoke (hardwood and softwood), cooking fumes (meat and vegetable), tobacco smoke, road dust, and coal-fired power plant emissions. These atmospheres will be analyzed in much greater detail than has been typical of toxicology studies, in order to test relationships between health responses and the hundreds of individual constituents and dozens of classes of constituents. See Research Protocol Laboratory health response assays comprising five general categories of

respiratory effects will be evaluated for each atmosphere, including irritation/inflammation, allergic responses/asthma, respiratory defenses, lung and heart function, and cancer. Several different laboratory health models and assays will be used to examine these effects which, in turn, encompass the key types of health responses commonly attributed to environmental air pollution

[Comparative Health Hazards of Emissions from Diesel and Gasoline Engines](#)

[\[EXIT disclaimer >\]](#)

This project will directly compare the toxicities of particles and semi-volatile organic emissions from representative gasoline and diesel engines. The approach is to use short-term assays of toxicity to develop a comparative toxicity ranking among the exhaust emission samples collected from engines representing specific types and usage.

[Asthma Vaccine](#)

[\[EXIT disclaimer >\]](#)



Research at

Lovelace, under the direction of Dr. David Bice, shows that the respiratory system can act as an immune organ separate from the rest of the body. When allergens are inhaled, some people produce allergic immune responses in their lungs resulting in asthma attacks. The vaccine will induce a protective response in the lungs instead

[Genetic and Environmental Factors that Contribute to Asthma](#)

[\[EXIT disclaimer >\]](#)

The major goal of Dr. Barrett's research is to understand the relative roles of both genetic and environmental factors that

contribute to asthma. To accomplish this, his lab is using new and different animal models of allergy / asthma to test and develop new drugs and therapies for treatment and prevention of allergies / asthma. Areas of research that are directed toward these goals include the contribution of cigarette smoke and ultrafine particles (air pollutants). We are currently performing studies that examine the release of these allergy-associated biochemicals in the lungs of animal models after exposure to ultrafine PM. One possible effect of these exposures might be to reduce the amount of allergen needed to cause an asthma attack.

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**Health Effects Institute**  
[HEI](#) EXIT disclaimer ➤ is a public private partnership established

to research and provide impartial information about the health effects of emissions from motor vehicles and other sources of environmental pollution. HEI receives half of its core funds from the EPA and half from twenty-eight manufacturers or marketers of motor vehicles or engines in the US.

The HEI research program has addressed many important questions about the health effects associated with exposure to both regulated pollutants such as carbon monoxide, ozone, and nitrogen dioxide, and unregulated pollutants such as diesel exhaust, aldehydes, and methanol. HEI has also funded studies to understand the mechanisms of diseases, to develop better methods to assess health effects and determine dose response relationships. The program has included theoretical, *in vitro*, animal, controlled human exposure, and epidemiological studies.

### **HEI PM Research Program**

This document summarizes the thrust of the [HEI PM program](#) EXIT disclaimer ➤ over a 5 year period of 94 to 98 and encompasses 34

A recent HEI report, [Acute Cardiovascular Effects in Rats from Exposure to Urban Ambient Particles](#), by Dr. Renaud Vincent and his colleagues at Health Canada was published in December. As we move down the path of trying to understand the health effects of PM, a key question is whether different components of particles, and different sources of those components, may pose more or less of a risk. At the same time, we need to better understand what mechanisms might be causing effects. This study takes a first step in this direction by measuring the acute cardiovascular effects of four different particle mixtures, including resuspended Ottawa ambient particles and diesel soot, compared to clean air.

research projects.

**PM related HEI completed projects:** (It would be best to make this into a pop up table like what comes out of the database listing the projects w links to abstracts and final reports - might want to ask mike if we can load them in to a special area to allow the table to be created and until they can be keyworded)

Daily Changes in Oxygen Saturation and Pulse Rate Associated with Particulate Air Pollution and Barometric Pressure

[Original](#)  
[Abstract](#)  
[Final Report](#)

Effects of Concentrated Ambient Particles on the Cardiac and Pulmonary Systems of Dogs

[Original](#)  
[Abstract](#)  
[Final Report](#)

Effects of Concentrated Ambient Particles in Rats and Hamsters: An Exploratory Study

[Original](#)  
[Abstract](#)  
[Final Report](#)

The National Morbidity, Mortality, and Air Pollution Study: Methods and Methodologic Issues

[Original](#)  
[Abstract](#)  
[Final Report](#)

The National Morbidity, Mortality, and Air Pollution Study: Morbidity and Mortality from Air Pollution in the United States

[Original](#)  
[Abstract](#)  
[Final Report](#)

Association of Particulate Matter Components with Daily Mortality and Morbidity in Urban

## HEI Publications

### [Recent Publications](#)

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Airborne Particles and Health: HEI Epidemiologic Evidence post pdf use graph from page 5

### Other HEI PM related publications in review or in press:

(\* = in review, † = in press)

(these also should be put into a table - I don't think there are any links to anything from these)

### Diesel

- †Paolo Boffetta, International Agency for Research on Cancer, Lyon, France Feasibility of an epidemiology study of diesel engine emissions in Central Europe and CIS
- †Murray Finkelstein, McMaster University, Toronto, Canada Cancer and diesel exhaust exposure in railroad workers: A feasibility study
- †Eric Garshick, Harvard University Medical School, Boston, MA Lung cancer risk and the quantitative assessment of diesel exhaust exposure
- †David Kittelson, University of Minnesota, Minneapolis, MN Diesel aerosol exposure
- Mark Witten, University of Arizona, Tucson, AZ Afferent neural responses of lungs exposed to diesel exhaust particulates
- †Barbara Zielinska, Desert Research Institute, Reno, NV

### Epidemiology

- Bert Brunekreef, Utrecht University, Utrecht, the Netherlands Long-term effects of traffic-related air pollution on respiratory and cardiovascular mortality
- Douglas Dockery, Harvard School of Public Health, Boston, MA Association of

## Populations

[Original](#)  
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## Acute Pulmonary Effects of Ultrafine Particles in Rats and Mice

[Original](#)  
[Abstract](#)  
[Final Report](#)

## Identifying Subgroups of the General Population That May Be Susceptible to Short-Term Increases in Particulate Air Pollution

[Original](#)  
[Abstract](#)  
[Final Report](#)

## Daily Mortality and Fine and Ultrafine Particles in Erfurt, Germany

[Original](#)  
[Abstract](#)  
[Final Report](#)

## A Case-Crossover Analysis of Fine Particulate Matter Air Pollution and Out-of-Hospital Sudden Cardiac Arrest

[Original](#)  
[Abstract](#)  
[Final Report](#)

## Penetration of Lung Lining and Clearance of Particles Containing Benzo[a]pyrene

[Original](#)  
[Abstract](#)  
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## Acute Cardiovascular Effects in Rats from Exposure to Urban Ambient Particles

[Original](#)  
[Abstract](#)  
[Final Report](#)

## Genetic Differences in Induction of Acute Lung Injury and Inflammation in Mice

[Original](#)  
[Abstract](#)

particulate air pollution with arrhythmias recorded by implanted cardioverter defibrillators Francesca Dominici, Johns Hopkins University, Baltimore, MD Air pollution and daily mortality in a national sampling frame

- Annette Peters, GSF-Forschungszentrum für Umwelt und Gesundheit, Oberschleissheim, Germany Particle air pollution and the onset of non-fatal myocardial infarction - a case crossover study

**Experimental**

- †Ann Aust, Utah State University, Logan City, UT Particle characteristics responsible for effects on human lung epithelial cells
- Mark Frampton, University of Rochester Medical Center, Rochester, NY Health effects of exposure to ultrafine carbon particles in healthy subjects and subjects with asthma
- Henry Gong, Los Amigos Research & Education Institute, Downey, CA Controlled laboratory evaluation of acute cardiopulmonary responses to concentrated particulates
- \*Fletcher Hahn, Lovelace Respiratory Research Institute, Albuquerque, NM Mechanisms of particle size- and composition-related adverse health effects in an aged sensitive population of rats
- Jack Harkema, Michigan State University, East Lansing, MI Effects of inhaled urban air particulates on normal and hypersecretory airways in rats Click here to read Research on Particulate Matter
- Stephen Holgate, University of Southampton, Southampton, UK Inflammatory mechanisms with exposure to air pollution particles

[Final Report](#)

Effects on Mice of Exposure  
to Ozone and Ambient  
Particle Pollution

[Original](#)  
[Abstract](#)  
[Final Report](#)

Emissions from Diesel and  
Gasoline Engines Measured  
in Highway Tunnels

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How Do Chemicals in Diesel  
Engine Exhaust Damage  
DNA?

[Original](#)  
[Abstract](#)  
[Final Report](#)

Relationship of  
Nitropyrene-Derived DNA  
Adducts to Carcinogenesis

[Original](#)  
[Abstract](#)  
[Final Report](#)

Particle Trap Effects on  
Heavy-Duty Diesel Engine  
Emissions

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[Final Report](#)

Interactive Effects of  
Nitropyrenes in Diesel  
Exhaust

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[Abstract](#)  
[Final Report](#)

Comparison of the  
Carcinogenicity of Diesel  
Exhaust and Carbon Black in  
Rat Lungs

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[Abstract](#)  
[Final Report](#)

An Investigation of DNA  
Damage in the Lungs of Rats  
Exposed to Diesel Exhaust

[Original](#)  
[Abstract](#)

- \*Debra Laskin, Rutgers University, Piscataway, NJ Role of peroxides and macrophages in fine particulate matter toxicity
- †Christine Nadziejko, New York University Medical Center, Tuxedo, NY Particulate matter and cardiovascular mortality
- Kent Pinkerton, University of California, Davis, CA Mechanisms of particle toxicity in the respiratory system Exposure Assessment
- \*Bert Brunekreef, Utrecht University, Utrecht, the Netherlands Personal and indoor exposure to fine particulate matter and its relationship to short-term changes in cardio-vascular and respiratory health indicators
- \*Beverly Cohen, New York University Medical Center, NY Field validation of nanofilm acid detectors for assessment of H<sub>+</sub> and ultrafine particles in indoor and outdoor air
- Alison Geyh, Johns Hopkins School of Hygiene and Public Health Field evaluation on the Personal Particle Speciation Sampler
- Susan Hering, Aerosol Dynamics, Inc., Berkeley, CA A personal particle speciation sampler
- Petros Koutrakis, Harvard School of Public Health, Boston, MA Characterization of the particulate and gas exposures of sensitive sub-populations living in Eastern U.S. metropolitan areas
- Barbara Turpin, Rutgers University, Piscataway, NJ Contributions of outdoor PM sources to indoor concentrations and personal exposures: A three city study

[Final Report](#)

No Evidence For Genetic Mutations Found In Lung Tumors From Rats Exposed To Diesel Exhaust or Carbon Black

[Original](#)[Abstract](#)[Final Report](#)

DNA Mutations in Rats Treated with a Carcinogen Present in Diesel Exhaust

[Original](#)[Abstract](#)[Final Report](#)

Effects of Fuel Modification and Emission Control Devices on Heavy-Duty Diesel Engine Emissions

[Original](#)[Abstract](#)[Final Report](#)[HEI Special Reports](#)[EXIT disclaimer ➤](#)

Periodically HEI analyzes and interprets the scientific issues pertaining to a specific environmental problem. The results of these analyses are published in HEI Special Reports. Brian put in titles and links to all of the reports on this HEI page - best to mount copies of them on our hei center page and link to them there - thanks

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**Environmental Lung Disease Center  
National Jewish Medical and Research Center**



The objectives of the [Environmental Lung Disease Center](#) are to improve the understanding of lung disease, and develop innovative early disease detection, prevention and treatment approaches. The center's research involves: 1) determining the molecular mechanisms of environmental and occupational lung disease, 2) identifying the genetic and molecular basis for individual susceptibility, and 3) identifying the risk and effects of air

pollution on human population with preexisting pulmonary diseases, and the exposure/host response relationship that leads to disease. EPA supported the Environmental Lung Disease Center as a Congressional line item or Targetted Center.

### **PM Related Research Projects:**

- [Particle-Induced Lung Inflammation and Extracellular EC-SOD](#)
  - [Inhalation of Particulate Matter Alters the Allergic Airway Response to Inhaled Allergen](#)
  - [Environment/Genetics in Beryllium Disease](#)
  - [The Role of delta gamma T Cells in Inflammation of the Lung](#)
  - [SP-A and SP-D in Environmental Lung Disease](#)
  - [Activation of Natural T Lymphocytes by Diesel Exhaust Particulates Leads to Their Production of Interleukin-4 and TH2 Lymphocyte Differentiation to Allergen](#)
  - [Immunopathogenesis of Hypersensitivity Pneumonitis in the Mouse](#)
  - [Indoor-Outdoor Relationships of Airborne Particle Count and Endotoxin Concentrations](#)
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Mickey Leland  
National Urban Air  
Toxics Research  
Center (NUATRC)  
The [Mickey Leland](#)  
[National Urban Air Toxics Research](#)  
[Center](#) [\[Exit disclaimer\]](#) (NUATRC),  
located in the Texas Medical Center, was

### **NUATRC - Publications**

#### *Center PM related Publications*

Personal Exposures to Toxic Air Pollutants: Vol. 1 Feasibility Study: Laboratory Evaluations and Field Method Comparison  
Drs. T.H. Stock and M.T. Morandi

Personal Exposures to Toxic Air Pollutants: Vol. 2 Feasibility Study: Results of the Laboratory Evaluation - Field Pilot Exposure Study: Personal Dosimeter Utilization Study - Modification of the 3500 OVM Passive Dosimeter Drs. T.H. Stock and M.T. Morandi

#### *Peer-reviewed PM related Publications*

Association of Heart Rate Variability With Occupational and Environmental Exposure to Particulate Air Pollution  
Circulation, Vol. 104, 968-991, 2001 Magari, S.R., Hauser, R., Schwartz, J., William, P.L., Smith, T.J., Christiani D.C.

Statistical distribution of particulate matter and the error associated with sampling frequency Atmospheric Environment, Vol. 35, No 16; 2907-2920, 2001 Rumburg B., Alldredge R., and Claiborn C.

Sampling Artifacts from the use of denuder tubes with glycerol based

authorized by the U.S. Congress in the Clean Air Act Amendments of 1990, and incorporated in 1991. It is named after the late Congressman Mickey Leland, whose efforts on behalf of public health contributed significantly to the passage of key amendments to the Clean Air Act.

The mission of the [NUATRC](#) is to develop and support research which will yield a better understanding of the potential risks posed to human health by exposure to air toxics, as defined by the 1990 Clean Air Act Amendments. The Center's research program, developed collaboratively by scientific experts from academia, industry and government, seeks to fill the gaps in scientific data that are required to make sound environmental health public policy decisions.

NAUTRC's objectives are to study health effects in human populations exposed to air toxics; develop new approaches and methods for assessing the potential risks resulting from exposures to air toxics; and to provide sound, peer-reviewed scientific data for regulatory purposes.

#### **Ongoing Research:**

VOCs, Aldehydes and Toxic Metals. In 1997, two major projects which are investigating personal exposures to air toxics in urban environments were funded by the Center. The first project is gathering data on personal exposures to VOCs, aldehydes and air toxics metals on respirable particulates among residents of urban areas in three geographic locations. The importance of residential air exchange rates and outdoor air concentrations in estimating indoor concentrations and personal exposures to air toxics will be investigated. · The second is focusing on personal exposures to urban air toxics among groups of students in two cities. The study will investigate the roles of seasonality, day-of-the-week, meteorologic conditions and activities on personal exposures to VOCs, aldehydes and metals on particles.

coating in the measurement of atmospheric particulate matter Environmental Science and Technology, Vol. 35, 40-44, 2001 Finn D., Rumburg B., Claiborn C., Barnesberger W., Siems W.F., Koenig J., Larson T., and Norris G.

## Toxic Metals

Because of the Center's interest in toxic metals and the known association between many of these toxic metals and fine particulate matter (PM), the Center turned its attention to the need for personal monitoring devices for fine PM. A contract was awarded to develop personal monitoring devices for fine PM that will provide continuous 24-hour sampling, separate particles by size, and be user-friendly. The long-term goal of this project is to have a device that can be used in studies to evaluate the association between exposure to toxic metals and health effects.

VOCs, Aldehydes and Toxic Metals. In 1997, two major projects which are investigating personal exposures to air toxics in urban environments were funded by the Center.

- The first project is gathering data on personal exposures to VOCs, aldehydes and air toxics metals on respirable particulates among residents of urban areas in three geographic locations. The importance of residential air exchange rates and outdoor air concentrations in estimating indoor concentrations and personal exposures to air toxics will be investigated.
- The second is focusing on personal exposures to urban air toxics among groups of students in two cities. The study will investigate the roles of seasonality, day-of-the-week, meteorologic conditions and activities on personal exposures to VOCs,

aldehydes and metals  
on particles.

### **Human Health Effects**

The Center funded its first projects focused on human health effects of air toxics in 1999. The air toxics of interest are metals associated with fine PM, and the projects are designed to investigate whether the toxic metals present in fine PM are implicated in respiratory, immunologic or cardiopulmonary responses in susceptible human populations. · The first is investigating the role of fine PM and metals in respiratory and cardiovascular responses in a cohort of boilermakers with and without chronic bronchitis. The project will be leveraged with funds from an NIH grant. · The second project is examining the association between respiratory health outcomes and ambient levels of particulate air toxic metals using a seven-year time series epidemiological and source apportionment study. The project will leverage a previous EPA study.

### **Community-Based Programs**

The Small Grants Program was designed for investigators who proposed short-term projects on exposures and/or health effects of urban air toxics. Two projects were funded in 1999 under the program. · The first study is assessing the relative contribution of outdoor sources to indoor levels of polycyclic aromatic hydrocarbons (PAHs) in urban residences; evaluating the sources of indoor PAHs; and examining the factors that control or modify the indoor sources of PAHs.

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**(STAR) Program  
Centers of Excellence**



**in Children's  
Environmental Health  
and Disease  
Prevention Research**



In 1998 EPA, NIEHS, and the CDC established eight Childrens Research centers to conduct basic and applied research in combination with community-based prevention efforts. The role of these centers is to better understand the causes of environmentally induced disease among children and to eventually decrease their prevalence. These centers were established in response to the Federal Executive Order of April 21, 1997, "Protection of Children from Environmental Health Risks and Safety Risks," which charged agencies to consider special environmental risks to children in their activities. Several of these centers are performing PM related research which is summarized below:

**University of Southern California**

*Children's Environmental Health Center  
University of Southern California*

The focus of the University of Southern California (USC) Children's Environmental Health Center is to develop a better understanding of how host susceptibility and environmental exposures contribute to children's respiratory disease. PM related research projects include:

- Project 1:  
[Children's Susceptibility to Air Pollution](#)
- Project 2:  
[Children's Exposure to Environmental Tobacco Smoke: Changes in Allergic Response](#)
- Project 3:  
[Asthma in Children: A Community-based Intervention Project](#)

**University of Iowa**

*The Etiology and Pathogenesis of Airway Disease in Children from Rural Communities University of Iowa*

The University of Iowa Childrens Center's program is investigating the etiology and pathogenesis of airway disease in children from rural communities. The primary hypothesis unifying this research program is that understanding the etiology and pathogenesis of airway disease in children from rural communities will provide the

scientific rationale to develop primary, secondary, and tertiary preventive programs that reduce the morbidity and mortality of asthma in the rural setting. PM related research projects are listed below:

- Project 1:  
[Multi-component Intervention Study of Asthma in Children from Rural Communities](#)
- Project 2:  
[A Model to Study the Development of Persistent Environmental Airway Disease](#)
- Project 3:  
[Mechanisms that Initiate, Promote, and Resolve Grain Dust/LPS Induced Inflammation](#)
- Project 4:  
[Role of RSV Infection and Endotoxin in Airway Inflammation](#)

### **University of Michigan**

*Michigan Center for the Environment & Children's Health (MCECH)*

MCECH is conducting research aimed at:

1. identifying children with asthma and assess their household, school, and neighborhood environment,
2. increasing knowledge and behavior to reduce environmental hazards in households and neighborhoods, thereby improving asthma-related health status,
3. examining the effects of daily and seasonal fluctuations in indoor and outdoor ambient air quality on pulmonary function and severity of asthma symptoms,
4. determining the effects of allergen-induced local, excessive production of chemokines on redox status and innervation of the bronchial tree, and
5. developing specific mechanisms for communication and translation of laboratory and community-based research across disciplines and to community partners. PM related research includes:
  - Core 1 Research Project:  
[A Community-Based Intervention to Reduce Environmental Triggers for Asthma Among Children \(Asthma Intervention\)](#)
  - Core 2 Research Project:  
[Indoor and Outdoor Air](#)

Contaminant Exposures and  
Asthma Aggravation Among  
Children (Asthma Exposure)

- Core 3 Research Project:  
Chemokines in the Pathogenesis of  
Asthma (Asthma Chemokines)

**Johns Hopkins University Hospital**

The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment Johns Hopkins University The long term goal of the Center for the Asthmatic Child in the Urban Environment is to understand how exposures to environmental pollutants and allergens may relate to airway inflammation and respiratory morbidity in children with asthma living in the inner city of Baltimore and to develop effective strategies to reduce morbidity by changing these exposures . Related PM research at this center includes:

- Project 1:  
Genetic Mechanisms of  
Susceptibility to Inhaled Pollutants
- Project 2:  
Mechanisms Of  
Particulate-Induced Allergic  
Asthma
- Project 3:  
The Relationship Of Airborne  
Pollutants And Allergens To  
Asthma Morbidity
- Project 4:  
A Randomized, Controlled Trial of  
Home Exposure Control in Asthma

**Columbia University School of Public Health**

Columbia Center For Children's Environmental Health Columbia University The mission of the Columbia Center for Children's Environmental Health (CCCEH) is to undertake a comprehensive community-based assessment of environmental risks to infants and children, and to develop strategies for reducing, and ultimately preventing, those risks. The Center is responsive to the urgent health needs of the minority communities in Northern Manhattan and the South Bronx, which suffer uniquely high rates of asthma, adverse birth outcomes, impaired development, and other diseases. Related PM research being conducted at this center includes:

- Project 2:

[Research on Asthma](#)

- Project 3:  
[Community-Based Intervention:](#)  
[Reducing Risks of Asthma](#)

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- [National Center for Environmental Assessment](#)
- [National Risk Management Research Laboratory/Air Pollution Prevention and Control Division](#)
- [National Health and Environmental Effects Research Laboratory](#)

[Related EPA Research](#)

### Other Related ORD Research



**National Center for Environmental Assessment (NCEA)**  
The [National Center for Environmental Assessment](#) (NCEA), a major component of ORD with headquarters in Washington, DC, is EPA's national resource center for human health and ecological risk assessment. NCEA conducts risk assessments, carries out research to improve the state-of-the-science of risk assessment, and provides guidance and support to risk assessors.



### (NCEA-RTP) National Center for Environmental Assessment - RTP

[NCEA-RTP](#) primarily develops and publishes air quality criteria documents for major air pollutants (PM, SO<sub>x</sub>, O<sub>3</sub>, NO<sub>x</sub>, CO, Pb) in support of NAAQS decision making, provides health and ecological assessments of air toxics in support of decision making on hazardous air pollutants, and provides assessments and scientific assistance on fuels/fuel

## External Partnership Projects

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additives (e.g., MMT, MTBE, etc.) in support of Agency mobile sources rule making actions. Through the CAA's Air RISC Information Support Center, NCEA-RTP also provides risk assessment information and assistance on air pollution problems to EPA Regions, other Federal government agencies, state and local authorities, and international agencies

**Air Quality Criteria for Particulate Matter - NCEA/RTP**

Another [NCEA-RTP](#) external review draft document is an updated revision of the Air Quality Criteria for Particulate Matter, published by the United States Environmental Protection Agency (EPA) in 1999, and it will serve as the basis for reevaluating the current National Ambient Air Quality Standards (NAAQS) for particulate matter (PM) set in 1997. The present external review draft critically assesses the latest scientific information relative to determining the health and welfare effects associated with exposure to various concentrations of PM in ambient air. The document is not intended as a complete and detailed literature review, but it does thoroughly evaluate information relevant to PM NAAQS criteria development based on pertinent literature available through December 2000.

The following ten items reflect ongoing or recently completed activities by ORD/NCEA many in support of The periodic (5 years) review of the National Ambient Air Quality Standard (NAAQS) for particulate matter (PM) and the subsequent determination by EPA and

NAS of particulate matter research needs have identified areas of uncertainty including health effects that may lead to a mechanism of PM action that need to be studied in order to improve future PM NAAQS reviews.

**Air Quality Criteria for Particulate Matter Document - NCEA/RTP**

The Clean Air Act mandated the periodic (5 years) process of updating information for the [Air Quality Criteria for Particulate Matter Document](#) (AQCD) started in fiscal year 1998 following the July 1997 promulgation of a new PM NAAQS. The outcome of this assessment activity is a document which is the basis of the risk assessment (OAQPS Staff Paper) supporting the NAAQS review and is typical of the activities NCEA conducts under its mission to serve as the national resource center for the overall process of human health and ecological risk assessment.

**Methods for Evaluating Human Inter-Individual Variability And Uncertainty in Health Risk Assessments for Particulate Pollutants - NCEA/RTP**

The goals of this [NCEA/RTP](#) research conducted in ORD/NCEA are to define and illustrate mathematically and biologically appropriate methods for estimating (1) human variability in response to particulate matter (PM) exposures and (2) health risks from PM exposures incorporating parameters governing human variability and uncertainties (both data and methods). The latter analysis will be tuned to the needs of

regulatory decision making frameworks.

**Oronasal Switching Point for Breathing Mode in Children And its Contribution to Fine Particle Deposition in the Respiratory - [NCEA/RTP](#)  
[TRACT](#)**

The objective of this research conducted by ORD/NCEA is to determine the ventilation rate at various levels of exercise and the oronasal switching point in children as compared to adults. Differences due to gender and race will also be evaluated. These data will be used to enhance the adult ventilation rate data on the oronasal switching point with additional subjects and with contemporary measurement techniques. These data will be the first data on these important ventilation parameters for children. Variability in these measurements will be determined between individuals for both children and adults to evaluate the appropriateness of the intrahuman uncertainty factor used in risk assessment. These ventilation data are needed to accurately model any particle deposition or gas (e.g., hazardous air pollutant) uptake in children.

**Filter and TEOM Pm1 and PM2.5, PM Chemical Components, and PM Source Categories as Alternate Indicators of PM Exposure In Epidemiologic Analyses for Cardiovascular, Respiratory, and Total Mortality in Phoenix - NCEA/RTP**

NERL operated a [monitoring platform](#) in Phoenix from 1995 to 1997. PM1 measurements were

made but only for about 8 months. The University of Washington has used the Phoenix data to determine source categories and to conduct an epidemiologic analysis but without any extensive analysis of the results or use of the PM1 data. Method: Additional analyses by inhouse staff supported by a contract to provide epidemiologic analyses using the health data and epidemiologic model developed by workers at the University of Washington. Results: The PM1 data has been used with the elemental composition data to estimate the intermodal mass (PM2.5-1). This could then be subtracted from the PM2.5 concentration values to give an estimated PM1 time series.

**Report Analyzing Existing NHAMES Data to Characterize Respiratory Effects in Children - NCEA/RTP**

This [study](#) by ORD/NCEA has used NHANES-III data from the National Center for Health Statistics (NCHS) to assess the respiratory health and function of children. NHANES-III was conducted in 89 locations across the USA from 1988-1994. We have limited our study to children up to 19 years of age (N= 14,000). We have analyzed several risk factors for respiratory effects in children based solely on the data collected in NHANES-III. The models developed in this part of the analysis examine risk factors such as active and passive smoking, presence of home combustion devices (gas stoves, fireplaces, etc.), atopic status of subjects, parental history of asthma and allergies, and socioeconomic and demographic characteristics of subjects and their families

to determine their effect on respiratory function (FVC, FEV1, etc.) of children.

**Relationships Between Ambient Concentration and Personal Exposure (Ambient, Nonambient, and Total) and Their Use as Exposure Surrogates in PM Community Time Series Epidemiology - NCEA/RTP**

As a result of a literature review use in preparation of the Exposure chapter for the 1996 Air Quality Criteria for Particulate Matter, NCEA staff begin a project to analyze the relationships between personal exposures (to ambient, nonambient and total) PM and ambient concentrations of PM.

Method: Inhouse project.

Results: Three papers published on concentration/exposure relationships. One describes techniques that can be used to estimate ambient and nonambient exposures if ambient concentrations of PM and total personal exposure to PM have been measured. Another paper, in internal EPA review, addresses The Exposure Paradox, the lack of a correlation between personal exposure and ambient concentrations even though there was a statistical relationship between ambient concentrations and health effects. The implications of using ambient, nonambient, or total exposure to PM instead of ambient concentrations of PM in epidemiologic analyses are being examined.

**Influence of Alternate Indicators of Exposure To PM (Or PM Components) in Statistical Correlations of Exposure with Mortality and Morbidity (Philadelphia Data Base) - NCEA/RTP**

At the time the Air Quality Criteria for Particulate Matter was prepared there were several epidemiologic studies using multiple years of TSP and PM10 data for the exposure estimate but only one epidemiologic study using multiple years of PM2.5 data. That study had concentration data only for every other day. At the time this project was initiated no report using daily PM2.5 for multiple years had been published. EPA supported the collection of a three-year data base of PM2.5 and PM10 from 1992-1995 in Philadelphia. EPA has [analyzed the filters from Philadelphia](#) using XRF.

The XRF concentrations, of elements from sodium to lead, have been used to estimate time series of daily PM concentrations associated with various sources. This information can be used to improve information on health risks of PM.

**Contribution of  
Semi-Volatile Particulate  
Matter to Ambient  
Suspended Fine Particle  
Mass - NCEA/RTP**

[NCEA/RTP](#) researchers Intercompared continuous (1-hour average) and 24-hour average measurements of PM2.5 using two new techniques that measure total (nonvolatile plus semivolatile) PM2.5 , the TEOM , integrating nephelometers sampling ambient and dehumidified air, and the Federal Reference Method. Advise OAQPS on use of continuous monitors in the regulatory network.

**National Dioxin Air  
Monitoring Network - The  
EPA's Particulate Matter  
(PM) Health Effects  
Research Centers**

**Program - NCEA/RTP**  
*A Mid-Course (2 1/2 year)  
Report of Status, Progress,  
and Plans Prepared for:  
Public Review by EPA's  
Science Advisory Board  
(SAB)*

The U.S. EPA has established a [National Dioxin Air Monitoring Network](#) (NDAMN) as a long-term data collection effort to determine the temporal and geographical variability of atmospheric CDDs, CDFs and dioxin-like PCBs at rural locations throughout the United States. NDAMN was established to provide a quantitative basis of linking sources of dioxin-like compounds with human exposure. This information will be used in the context of devising Agency-wide strategies to reduce human exposures to these highly toxic chemicals.

**Ambient PM Exposure And Respiratory Health in 4 Chinese Cities: U.S. Component - NCEA/RTP**

This is a project to [quality-assure, analyze, and publish data](#) from an epidemiologic study of respiratory health in relation to ambient PM exposure in the 4 Chinese cities of Chongqing, Guangzhou, Lanzhou, and Wuhan. First-priority reports in this 3-year project will describe effects of exposure to size-specific ambient PM, and to indoor coal smoke, on prevalence of respiratory illnesses and symptoms in grade school children and their parents, and on long-term growth of spirometric lung function in the children. If time and resources permit, additional reports will present normative growth curves of Chinese urban children's lung function, and will compare these to U.S.

children's growth curves.

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[APPCD](#) is concentrating its efforts in six main program areas: Air Toxics, Fine Particles, Indoor Air Quality, Ozone Non-Attainment/NOX and Volatile Organic Compounds (VOC), Global Climate Change, and Environmental Technology Verification. The research is conducted and managed primarily by chemical engineers and is accomplished through a variety of mechanisms including:

in-house research;

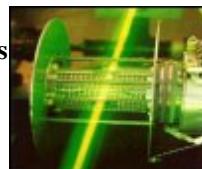
cooperative agreements with academia and non-profit organizations;

interagency agreements with other federal entities;

cooperative research and development agreements with the private sector under the Federal Technology Transfer Act of 1986; and

contracts with environmental consultants and for-profit companies.

**Real-Time Monitoring of Dioxins and Other Ambient Air Trace Organics**



The project objectives will be to develop the [REMPI](#) instrumental method into a tool that will be used for assessment of potential dioxin sources, control and prevention of dioxin formation in known sources, and communication of facility performance. This will be accomplished through instrument development, laboratory verification, thermokinetic modelling, equilibrium modelling, statistical determinations, field validation, program publication and presentation, regulatory office support, and development of data communication/presentation procedures.

**Air Pollution Technology Branch (APTB)**  
*(part of EPA's National Risk Management Research Laboratory (NRMRL), Air Pollution Prevention and Control Division (APPCD))*

Fundamental and applied combustion research has been conducted by [APTB](#) and its predecessors since EPA's beginning, and we have been instrumental in the development and successful application of flue gas desulfurization systems on utility power plants. Studies include evaluation of on-line gas chromatographs (GCs) for monitoring of waste incinerator emissions and chemical and physical characterization of PM 2.5 from combustion sources.

### **Emissions Characterization and Prevention Branch**

*(part of EPA's National Risk Management Research Laboratory (NRMRL), Air Pollution Prevention and Control Division (APPCD)) Fine Particle (PM-2.5)*

The objective of the [Emissions Characterization](#) program is to focus on characterization of fine particle emissions that are responsible for increased mortality in urban areas. Particles 2.5 microns or smaller (PM-2.5) which are emitted from the largest regional sources are targeted. Projects include measurement of PM-2.5 from instrumented heavy duty diesel trucks during operation on roadways, wood stoves, fireplaces, and fugitive emissions from construction sites. Characterization of major ammonia fugitive emission sources which form secondary PM-2.5 in the atmosphere from livestock and comparison of alternative particle size classifying equipment are also critical areas under study.

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### **ORD/National Health and Environmental Effects Research Laboratory - ORD/NHEERL**



[NHEERL](#) is conducting studies of adults and children to characterize relationships between PM and co-pollutant exposure and health indices, and we are linking epidemiological studies of PM's effects to toxicology studies in laboratory animals. We are performing in vivo and in vitro toxicology studies in animals and humans to examine dosimetric relationships, to identify the characteristics of PM that produce effects, and to elucidate mechanisms of action. In order to study factors affecting

susceptibility, we are developing animal models that can mimic human diseases, such as asthma.

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### **Related EPA Research**



**Office of Air Quality Planning and Standards (OAQPS)**

The [Office of Air Quality Planning and Standards](#)

(OAQPS) primary mission is to preserve and improve air quality in the United States. OAQPS, as part of this goal, monitors and reports on air quality, air toxics , and emissions. They also watch for visibility issues, as they relate to the level of air pollution. In addition, OAQPS is tasked by



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- [Office of Air Quality Planning and Standards](#)
- [Air Pollution Technology Transfer Network](#)
- [PM2.5 Monitoring Program](#)
- [AIRData](#)
- [Health and Environmental Impacts of PM](#)
- [Support Center for Regulatory Air Models](#)
- [Aerometric Information Retrieval System](#)
- [Envirofacts Warehouse](#)
- [Air Toxics Website](#)

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the EPA with providing technical information for professionals involved with monitoring and controlling air pollution, creating governmental policies, rules, and guidance for professionals and government, and educating the public about air pollution and what can be done to control and prevent it.

**Final Revisions to the Ozone and Particulate Matter Air Quality Standards**

Recently EPA completed its [final revisions](#) of the current air quality standards for ground-level ozone (commonly known as smog) and particulate matter (or PM). Based on new scientific evidence, EPA has issued final revisions to strengthen both sets of standards. The revised standards will provide additional protection to nearly 125 million Americans, including 35 million children. EPA has also proposed a new program to control regional haze, which is largely caused by particulate matter.

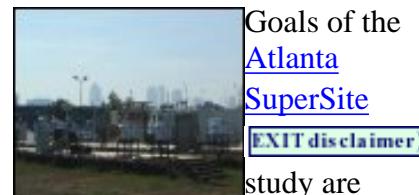
**PM Supersites Program**

The [PM Supersites](#) is an ambient monitoring research program intended to address the scientific uncertainties associated with fine particulate matter. Program goals focus on fine particulate characterization, methods testing, and support to health effects and exposure studies.

## Supersite Program - QA, Progress, Individual sites

This [OAQPS site](#) relays detailed QA information about each study and links to descriptive information documenting the component research projects of each Supersite program.

### Atlanta SuperSite Experiment



study are twofold: first, to provide a platform for testing and contrasting some of the newer particle measurement techniques, and second, to provide data to advance our scientific understanding of atmospheric processes regarding atmospheric particles.

### Southern California Particle Center and Supersite (SCPCS)



The overall objective of the [Southern California Particle Matter Supersite](#) [EXIT disclaimer ➤](#)

is to conduct research and monitoring that contributes to a better understanding of the measurement, sources, size distribution chemical

composition and physical state, spatial and temporal variability and health effects of suspended particulate matter (PM) in the Los Angeles Basin. The research objectives of the Southern California Particulate Matter Supersite are:

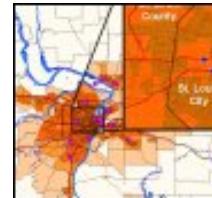
1. To characterize PM, its constituents and precursors, to better understand sources and transport affecting human exposure and to support development of State Implementation Plans (SIPs).
2. To obtain atmospheric measurements to support health studies designed to address causal factors; etiologic pathways and mechanisms of PM related morbidity and mortality with particular emphasis on PM source-receptor-exposure-effects pathways.
3. To conduct methods testing that will enable comparisons and evaluation of different technologies for characterizing PM including evaluation of new instrumentation, sampling methods and federal reference methods.

*Research objectives of the*

*SCPCS include:*

- To make use of ambient particle concentrators for exposure assessment and toxicological research.
- To emphasize chemical and physical characterization of PM, especially size distribution, in the study of the relationship between PM and associated morbidity and mortality
- To emphasize mechanistic toxicological research including in vitro, animal and human approaches for better understanding of the underlying bases for increased morbidity and mortality associated with exposure to PM
- To conduct toxicological research which reduces the uncertainties in the identification of causative PM constituents
- To investigate the role of allergens and bioaerosols in the morbidity and mortality associated with PM exposure
- To better characterize the relationship between mobile sources and airborne PM in the Southern California basin
- To investigate the

relationship between outdoor, indoor and personal exposures to PM

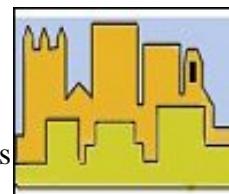


### St Louis Supersite Program

A series of exposure assessment, epidemiological, and toxicological studies will be integrated into the [St. Louis Supersite program](#)

[\[EXIT disclaimer ▶\]](#). These investigations will be conducted as part of three currently funded research programs: the EPA/Harvard Center on ambient particle health effects (1999-2004), the NIEHS/Harvard Program Project on ambient particles cardiac vulnerability in humans (1999-2004), and the EPRI Exposure Assessment Research Program (2000-2002). Six integrated research projects - involving exposure assessment, epidemiological, and toxicological study will rely on the Supersite measurements and therefore will be coordinated with the Supersite program.

### Pittsburgh Supersite Program



The objectives of the [Pittsburgh Air Quality Study](#)

[\[EXIT disclaimer ▶\]](#) are:

- to characterize PM (size, surface, and volume distribution, chemical composition as a function of size and on a single particle basis, morphology, and temporal and spatial variability) in the Pittsburgh region;
- to quantify the impact of the various sources (transportation, power plants, biogenic, etc.) to the PM concentrations in the area; and to
- develop and evaluate the next generation of atmospheric aerosol monitoring techniques (single particle measurements, continuous composition measurements, ultrafine aerosol measurements, improved organic component characterization, etc.).

Combining the ambient monitoring study with the indoor, health, and modeling studies will allow PAQS to:

- elucidate the links between PM characteristics and their health impacts;
- quantify the relationship between indoor and outdoor concentrations;

and

- quantify the responses of PM characteristics to changes in emissions to support regulation development.

### Fresno Supersite Program

The [Fresno Supersite](#) intends to:

1) test and evaluate non-routine monitoring methods, with the intent to establish their comparability with existing methods and determine their applicability to air quality planning, exposure assessment, and health impact determination; 2) increase the knowledge base of aerosol characteristics, behavior, and sources so regulatory agencies can develop standards and strategies that protect public health; and 3) acquire measurements that can be used to evaluate relationships between aerosol properties, co-factors, and observed health end-points.

### Houston Supersite Program



is a cooperative effort of more than 30 public, private and academic institutions utilizing the expertise of more than 150

scientists and engineers from throughout the country. The goal of the study is to develop scientific information that will be used to develop better assessment tools and more efficient and cost-effective strategies to improve air quality in Texas. The study will look not only at the sources of ozone precursors and fine particulate matter, but also how these pollutants move across regions of the state. The results of the study also will provide valuable information for areas of the country similar to Texas.

### Baltimore Supersite Program

The primary objectives of the [Baltimore Supersite Program](#)



[\[EXIT disclaimer ▶\]](#) will be to i) provide an extended, ultra high-quality multivariate data set, with unprecedented temporal resolution, designed to take maximum advantage of advanced new factor analysis and state-of-the-art multivariate statistical techniques; ii) provide important information on the potential for health effects of particles from specific sources and generic types of sources, iii) provide large quantities of well characterized urban PM for retrospective chemical, physical, biologic analyses and

toxicological testing, iv) provide sorely needed data on the sources and nature of organic aerosol presently unavailable for the region, and v) provide support to existing exposure and epidemiologic studies to achieve enhanced evaluation of health outcome-pollutant and -source relationships.



**New York  
Supersite  
Program**  
**PM2.5  
Technology**

[Assessment and  
Characterization Study-New](#)

[York](#) [\[EXIT disclaimer ▶\]](#) is one of several U.S. EPA "Supersites" intended to provide enhanced measurement data on chemical and physical composition PM and its associated precursors. The science team lead by the University at Albany (PI: Kenneth Demerjian, ASRC/DEAS), includes investigators from ten participating institutions. The science team will collect, analysis and interpret these data to 1) characterize the PM2.5/Co-pollutant complex and its related sources and sinks; 2) support health effects and exposure research; 3) evaluate new measurement technologies and establish their potential for routine monitoring; and establish and demonstrate the

use of these data analyses to track mitigation progress and support an accountable air quality management process.

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### Air Pollution Technology Transfer Network

The [Technology Transfer Network](#) (TTN) is a collection of technical Web sites containing information about many areas of air pollution science, technology, regulation, measurement, and prevention. In addition, the TTN serves as a public forum for the exchange of technical information and ideas among participants and EPA staff.

[Office of Transportation and Air Quality](#)  
[Highway Vehicle Particulate Emission](#)  
[Modeling Software](#)

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### PM2.5 Monitoring Program



The [PM2.5 Monitoring Program](#) is divided into a laboratory component and a field sampling component, followed by data validation, analysis, and reporting.

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### AIRData

The [AIRData](#) Web site gives you access to air pollution data for the entire United States.

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## Health and Environmental Impacts of PM



Many scientific studies have linked the [impacts](#) of breathing PM to a series of significant health problems, including: aggravated asthma, increases in respiratory symptoms like coughing and difficult or painful breathing, chronic bronchitis, decreased lung function, and premature death.

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## Support Center for Regulatory Air Models

The [Support Center for Regulatory Air Models](#) is a source of information on atmospheric dispersion (air quality) models that support regulatory programs required by the Clean Air Act. Documentation and guidance for these computerized models are a major feature of this website. The computer code, data and technical documents offered herein deal with mathematical modeling for the dispersion of air pollutants.

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## Aerometric Information Retrieval System (AIRS)



[AIRS](#) is composed of a group of different data bases. One of these, AFS, contains emissions and compliance status data on individual sources. AIRS primarily contains data on emissions of the criteria pollutants [VOC, NOX, SO<sub>2</sub>, CO, PM, and

Lead]. This data could be used to help you identify large emitters of criteria pollutants in a particular area. One link describe how to prepare a Freedom of Information Act (FOIA) request to obtain data from AIRS.

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### **Envirofacts Warehouse**

- [Air Releases Query Form](#) allows you to do a real-time search of AIRS/AFS for information on specific facilities, all facilities in a given geographic area, or all facilities with specific SIC codes.
- The Toxics Release Inventory (TRI) offers three sites ([TRI State Reports](#), [TRI Query Form](#), and [TRI Customized Query Engine](#)) that allow you to generate data reports that identify specific sources and the extent of their air emissions of up to 650 toxic chemicals and compounds, including most of the hazardous air pollutants (HAP). This information could be used to help you identify large emitters of HAP in a particular area.
- [Maps on Demand](#) generates GIS maps that display locations of facilities and the surrounding demographics for a State or county.
- "[Risk-Screening Environmental Indicators](#)" A computer-based (Windows 3.1/95/98) model that permits screening-level analysis of risk-related impacts of toxic chemical releases and transfers in the U.S.

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Air  
Toxics  
Website  
(ATW)



The [Air](#)

[Toxics Website](#) (ATW) EPA's clearinghouse for air toxics information from Federal, State, Tribal and Local air pollution control agencies.

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## Tabular Query Results of NCER Program and Solicitation Information

**67 Abstracts are listed**

**Your Query was:**

**(PM <or> particulate matter) <and> (exposure)**

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30. 2001	<a href="#">Highlighted</a>
2	R825267	<a href="#">Development of Population-Based Particle Exposure Models for Human Health Risk Assessment</a>	Harvard University	John D. Spengler	Deran Pashayan	\$500,065	December 2, 1996 - December 1, 1999	<a href="#">Highlighted</a>

3	R827355C003	<a href="#">Personal PM Exposure Assessment</a>	University of Washington, Washington State University	L-J Sally Liu, Candis Claiborn, Lara Gundel, Timothy Larson	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
4	R827353C001	<a href="#">Assessing Human Exposures to Particulate and Gaseous Air Pollutants</a>	Harvard University	Petros Koutrakis	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
5	R827355	<a href="#">Northwest Research Center for Particulate Air Pollution and Health University of Washington</a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
6	R827352	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	University of California at Los Angeles; California Institute of Technology; Rancho Los Amigos Medical Center; University of California at Irvine; University of California at Riverside; University of Southern California	John R. Froines [jfroines@ucla.edu] (Center Director), Steven D. Colome (Co-Center Director) and Richard P. Turco (Co-Center Director), Arthur K. Cho, Yoram Cohen, Annmarie Elderling, Sheldon K. Friedlander, Stella C. Grosser, Oliver Hankinson, William C.	Stacey Katz	\$8,715,583	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
7	R826724	<a href="#">Mechanisms Of Particulate-Induced Allergic Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Marsha Wills-Karp, Ph.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>

	8	R826768	<a href="#">Modeling and Evaluation of Mechanisms Controlling the Outdoor/Indoor Relationships of Fine Particle Levels and Characteristics</a>	University of Medicine and Dentistry of New Jersey	Panos G. Georgopoulos	Paul Shapiro	\$170,828	October 1, 1998 - September 30, 2000	<a href="#">Highlighted</a>
	9	R825702	<a href="#">Inhalation of Particulate Matter Alters the Allergic Airway Response to Inhaled Allergen</a>	National Jewish Medical and Research Center	Erwin Gelfand, M.D., Larry Borish, M.D.	Stacey Katz	none	none	<a href="#">Highlighted</a>
	10	R828686	<a href="#">Spatial and Temporal Models for Environmental Health Effects</a>	Duke University, Durham, NC	Merlise Clyde (clyde@stat.duke.edu)	Chris Saint	\$557,859	February 12, 2001 - February 11, 2004	<a href="#">Highlighted</a>
	11	R827995	<a href="#">Health Effects of Concentrated Ambient Particles from the Central Valley of California</a>	University of California, Davis; University of Southern California	Kent E. Pinkerton; Constantinos Sioutas	Deran Pashayan	\$633,328	02/01/2000 to 01/31/2003	<a href="#">Highlighted</a>
	12	R826783	<a href="#">Relationship of Ambient Particulate Matter to Heart Rate Variability and Cardiac Arrhythmias in Elderly Adults with Coronary Artery Disease</a>	California Office of Environmental Health Hazard Assessment (1), University of California (UC), San Francisco (2), UC Berkeley (3), UC Los Angeles (4), Eisenhower Medical Center, Rancho Mirage, CA (5)	Bart Ostro (1), Michael Lipsett (1), (2), Ira Tager (3), Mary Woo (4), Merle Bolton (5)	Deran Pashayan	\$436,964	October 1, 1998 September 30, 2000	<a href="#">Highlighted</a>
	13	R826244	<a href="#">Mechanism of PM-Induced Acute Health Effects</a>	New York University Medical Center	Terry Gordon	Deran Pashayan	\$600,799	January 23, 1998 - January 22, 2,001	<a href="#">Highlighted</a>

14	R825268	<a href="#">Pulmonary Toxicity of Particulate Matter and Ozone</a>	New York University Medical Center	Lung Chi Chen	Deran Pashayan	\$172,446	November 18, 1996 - November 17, 1998	<a href="#">Highlighted</a>
15	R827353C005	<a href="#">Assessing Life-Shortening Associated with Exposure to Particulate Matter</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
16	R825264	<a href="#">Acidic PM and Daily Human Mortality in Three U.S. Cities</a>	New York University Medical Center	George D. Thurston	Deran Pashayan	\$383,008	November 18, 1996 - November 17, 1999	<a href="#">Highlighted</a>
17	R827355C002	<a href="#">Health Effects of PM in Susceptible Populations</a>	University of Washington	Jane Q. Koenig, Joel Kaufman, Carol Trenga, Jeff Sullivan, Sally Liu, Tim Larson, Lianne Sheppard, Thomas Lumley, Karen Jansen	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
18	R827999	<a href="#">Acute Cardiopulmonary Responses to Fine Particulate Pollution and Copollutant Oxidant Gase in Los Angeles</a>	Rancho Los Amigos National Rehabilitation Center; University of Southern California	Henry Gong, Jr.; Constantinos Sioutas	Deran Pashayan	\$613,894	03/15/2000 to 03/14/2003	<a href="#">Highlighted</a>
19	R827351	<a href="#">Health Risks of PM Components</a>	New York University School of Medicine; University of Iowa	Morton Lippmann [lippmann@charlotte.med.nyu.edu] (Center Director), Richard B. Schlesinger (Co-Center Director), Beverly S. Cohen, Terry Gordon, Joan Reibman, George D. Thurston, Lung Chi Chen, Kazuhiko K. Ito, Christine C. Nadziejko, Judith T. Zelikoff,M	Gail Robarge	\$8,076,438	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
20	R827355C001	<a href="#">Epidemiologic Study of Particulate Matter and Cardiopulmonary Mortality</a>	University of Washington	Joel Kaufman, Harvey Checkoway, Lianne Sheppard, David Siscovick, Jane Koenig	Joel Kaufman, Harvey Checkoway, Lianne Sheppard, David Siscovick, Jane Koenig	none	Gail Robarge/Stacey Katz	<a href="#">Highlighted</a>

	21	R827996	<a href="#">Inhalability of Particulate Matter in Laboratory Animals</a>	Chemical Industry Institute of Toxicology	Bahman Asgharian	Deran Pashayan	\$335,903	01/17/2000 to 01/16/2002	<a href="#">Highlighted</a>
	22	R827354	<a href="#">Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</a>	University of Rochester; California Institute of Technology; University of California at Riverside; GSF - National Research Center for Environment & Health (Neuherberg, Germany); Research Triangle Institute; State University of New York at Buffalo; Univer	Gunter Oberdorster (Center Director), Mark Utell (Co-Center Director), William Beckett, Christopher Cox, Jacob Finkelstein, Mark Frampton, John Looney, Victor Marder, P. E. Morrow, Michael O'Reilly, Richard Phipps, Edward Schwarz, Barry Stripp and Wojciec	Gail Robarge	\$8,302,447	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
	23	R827353C006	<a href="#">Investigating Chronic Effects of Exposure to Particulate Matter</a>	Harvard University	Douglas Dockery	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
	24	R827353C002	<a href="#">Quantifying Exposure Error and its Effect on Epidemiological Studies</a>	Harvard University	Helen Suh	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	25	R826785	<a href="#">Effects of Inhaled Ultrafine Particles on Asthma</a>	Lovelace Respiratory Research Institute, Albuquerque, NM.	David E. Bice, T.K. Redman, K.J. Nikula, E.B. Barr, Y.S. Cheng	Deran Pashayan	\$545,147	October 1, 1998 September 30, 2001	<a href="#">Highlighted</a>
	26	R825266	<a href="#">Air Pollution and Hospital Admissions in Washington State</a>	Fred Hutchinson Cancer Research Center	Suresh H. Moolgavkar	Deran Pashayan	\$420,056	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>

	27	R827994	<a href="#">Cardiovascular Responses to Particulate Air Pollution</a>	Pennsylvania State University; University of North Carolina at Chapel Hill	Duanping Liao, Vernon M. Chinchilli; Gerardo Heiss, Carl Shy	Deran Pashayan	\$607,630	January 2000 - January 2003	<a href="#">Highlighted</a>
	28	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	29	R826270	<a href="#">Mechanisms of Particulate-Induced Mediator Expression in Human Airway Epithelial Cells</a>	University of North Carolina at Chapel Hill	William Reed, Lee M. Graves	Deran Pashayan	\$374,170	December 15, 1997 - December 14, 2000	<a href="#">Highlighted</a>
	30	R826780	<a href="#">Cardiovascular Vulnerability to Particulate Pollution</a>	Harvard School of Public Health	Diane R. Gold, Peter Stone, Augusto Litonjua; Richard Verrier, Joel Schwartz	Deran Pashayan	\$648,227	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	31	R827027	<a href="#">Growth and Development: Prenatal Exposure PAH</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	32	R827355C004	<a href="#">Dosimetry Assessment: Aerosol Number, Size Distribution, and Dosimetry Measurements and Modeling</a>	University of Washington	David S. Covert, Timothy Larson, Eugene Kim, Rob Elleman	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

	33	R827353C010	<a href="#">Relating Changes in Blood Viscosity, Other Clotting Parameters, Heart Rate, and Heart Rate Variability to Particulate and Criteria Gas Exposures</a>	Harvard University	Frank Speizer	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	34	R826782	<a href="#">Airborne Particulate Matter-Induced Lung Inflammation</a>	University of Texas Houston Health Science Center	Andrij Holian, Maria T. Morandi, Edwin Parsley	Deran Pashayan	\$674,288	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	35	R829216	<a href="#">Effects of Airborne Particles on Allergic Airway Disease</a>	(1)Michigan State University, East Lansing, MI; (2)University of Southern California and the Southern California Particle Center and Supersite, Los Angeles, CA	Jack Harkema, DVM, Ph.D., (PI) [harkemaj@msu.edu](1); Constantinos Sioutas, Ph.D. (Co-PI)(2)	Gail Robarge/Stacey Katz	\$854,702	October 31, 2001 û October 30, 2004	<a href="#">Highlighted</a>
	36	R827353C003	<a href="#">Differentiating Health Effects of Particles from Outdoor and Indoor Sources</a>	Harvard University	Diane Gold, Peter Stone	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	37	R826246	<a href="#">Particle Toxicity and the Respiratory Bronchiole</a>	University of California	Kent E. Pinkerton, Alan Buckpitt, Charles Plopper	Deran Pashayan	\$525,000	February 1, 1998 - January 31, 2001	<a href="#">Highlighted</a>
	38	R828733	<a href="#">Modeling Heat and Air Quality Impacts of Changing Urban Land Uses and Climate</a>	Columbia University1, Montclair State University2, Rutgers University3, State University of NY at Albany4	Patrick L. Kinney1 (plk3@columbia.edu), William D. Soleki2, Roni Avissar3, S.T. Rao4, Christopher Small1	Bernice Smith	\$1,496,418	September 1, 2000 - August 31, 2003	<a href="#">Highlighted</a>

	39	R829215	<a href="#">Health Effects of Airborne Particulate Matter and Gasses</a>	University of California, Davis, Davis, CA (1); University of Utah, Salt Lake City, UT (2); and Utah State University, Logan, UT (3)	(3)	Stacey Katz/Gail Robarge	\$833,481	October 1, 2001 - September 30, 2004	<a href="#">Highlighted</a>
	40	R829214	<a href="#">Mechanisms of Air Pollutant-induced Pulmonary Inflammation; Effects of Zinc on EGFR Receptor Function</a>	University of North Carolina, Chapel Hill, NC	Lee M. Graves (lmg@med.unc.edu), Weidong Wu	Gail Robarge/Stacey Katz	\$874,125	November 19, 2001 ù November 18, 2004	<a href="#">Highlighted</a>
	41	R828046	<a href="#">Pulmonary and Systemic Effects of Inhaled Ultrafine Particles in Senescent Rats with Cardiovascular Disease</a>	University of Rochester	Alison C.P. Elder, Jean-Philippe Couderc, Mark Frampton, G3nter Oberdörster, Wojciech Zareba	Deran Pashayan	\$408,859	March 24, 2000 - March 23,2003	<a href="#">Highlighted</a>
	42	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	Harvard University	John Godleski	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	43	R826784	<a href="#">Lung Injury from Inhaled Ultrafine Particles in Compromised Rats of Old Age: Influence of Priming and Adaptation</a>	University of Rochester (NY)	Günter Oberdörster and Jacob N. Finkelstein	Deran Pashayan	\$606,545	September 21, 1998 September 20, 2001	<a href="#">Highlighted</a>
	44	R825271	<a href="#">An Evaluation of Confounders in PM10/Mortality Associations</a>	New York University Medical Center	Kazuhiko Ito	Deran Pashayan	\$363,394	November 25, 1996 - November, 24, 1999	<a href="#">Highlighted</a>

45	R827355C005	<a href="#">Mechanisms of Toxicity of PM Using Transgenic Mouse Strains</a>	University of Washington	Daniel Luchtel, Timothy Larson; Consultants: Warren Ladiges, Joellen Lewtas	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
46	R829213	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#">Highlighted</a>
47	R827027	<a href="#">Research on Asthma</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
48	R824791	<a href="#">Distribution of H+ and Trace Metals in Ultrafine Ambient Aerosol</a>	New York University Medical Center	Beverly S. Cohen	Deran Pashayan	\$589,560	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
49	R826779	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	Harvard University	Lester Kobzik, Petros Koutrakis, Stephanie Shore, Beatriz Gonzalez-Flecha	Deran Pashayan	\$557,340	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
50	R826724	<a href="#">A Randomized, Controlled Trial of Home Exposure Control in Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Peyton A. Eggleston, M.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
51	U91-5361	<a href="#">Studies of Aerosol Composition, Partitioning and Heterogeneous Chemistry using Infrared Spectroscopy</a>	University of North Carolina at Chapel Hill	Cindy DeForest Hauser	Georgette Boddie	22,978	8/16/98	<a href="#">Highlighted</a>

	52	R827998	<a href="#">Health Effects of long-Term Exposure to Particles and Other Air Pollutants in Elderly Nonsmoking California Residents</a>	Loma Linda University	Synnove F. Knutsen, David E Abbey and Larry Beeson	Deran Pashayan	\$763,910	March 1, 2000 -- February 28, 2003	<a href="#">Highlighted</a>
	53	R828731	<a href="#">Implications of Climate Change for Regional Air Pollution, Health Effects and Energy Consumption Behavior</a>	The Johns Hopkins University, Baltimore, MD; George Washington University, Washington, DC	J.H. Ellis (PI-JHU) [hugh.ellis@jhu.edu], B.F. Hobbs (JHU), J.F. Patz (JHU), J. Samet (JHU), M. Schwab (JHU), F. Joutz (GW)	Bernice Smith	\$1,376,739	September 1, 2000 - August 31, 2003	<a href="#">Highlighted</a>
	54	R826245	<a href="#">The Relative Associations of Transition Metals and Sources of Fine Particulate Matter to Increased Daily Mortality</a>	Harvard University, School of Public Health	Joel Schwartz	Deran Pashayan	\$ 211,733	January 14, 1998 - January 13, 2,000	<a href="#">Highlighted</a>
	55	R826781	<a href="#">Human Health Effects of Exposure to Ultrafine Particles</a>	University of Rochester School of Medicine and Dentistry	Mark W. Frampton, Mark J. Utell, Gunter Oberdorster, Victor Marder, Wojciech Zareba	Deran Pashayan	\$736,260	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	56	R827353	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	Harvard University	Petros Koutrakis [petros@hsph.harvard.edu] (Center Director), John J. Godleski, (Center Co-Director), Joel Schwartz, (Center Co-Director), Douglas W. Dockery, Frank E. Speizer, Helen H. Suh, Diane R. Gold, Richard L. Verrier, James Ware, Paul Catalano, Jo	Stacey Katz	\$7,747,040	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	57	R825305	<a href="#">Development of a Continuous Monitoring System for PM10 and Components of PM2.5</a>	New York University Medical Center	Morton Lippmann	Bill Stelz	\$436,262	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>

	58	R826786	<a href="#">Characterization of Factors Determining Personal Exposure to Volatile Air Toxics in Urban Environments</a>	University of Oklahoma Health Sciences Center	N.A. Esmen, T.A. Hall, D.L. Johnson, and M.L. Phillips	Deran Pashayan	\$559,352	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	59	R826778	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	Lovelace Biomedical and Environmental Research Institute (NM)	Janet M. Benson (PI), Edward B. Barr, David E. Bice, Yung-Sung Cheng, Joe L. Mauderly	Deran Pashayan	\$199,035	October 1, 1977 - September 30, 1999	<a href="#">Highlighted</a>
	60	R827058	<a href="#">Time-Relevant Communication of Ozone and Particulate Air Pollution Data: A Pilot Project to Raise Public Awareness and Promote Exposure Reduction</a>	Suffolk County Conservation District, Massachusetts	Matthew Goode, Suffolk County Conservation District; Lee Alter, Northeast States for Coordinated Air Use Management; Petros Koutrakis, Harvard School of Public Health; Penn Loh, Alternatives for Community & Environment; Nancy Seidman, Massachusetts De	Madalene Stevens	\$527,000	November 1, 1998 - October 31, 2000	<a href="#">Highlighted</a>
	61	R826773	<a href="#">A Modeling Investigation of NH<sub>x</sub> Cycling in the Troposphere and Its Impact on Particulate Matter and Acidic Substances Budgets</a>	MCNC-North Carolina Supercomputing Center	Rohit Mathur, Uma Shankar, Carlie J. Coats, John McHenry, and Marc Houyoux	Paul Shapiro	\$488,744	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>

62	R826770	<a href="#">Development of Techniques for Assimilating GOES Satellite Data into Regional-Scale Photochemical Models</a>	University of Alabama in Huntsville	R. T. McNider, W. B. Norris, and S. A. Christopher	Paul Shapiro	\$404,127	July 1, 1998 - June 30, 2001	<a href="#">Highlighted</a>
63	R827027	<a href="#">Community-Based Intervention: Reducing Risks of Asthma</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
64	R825702	<a href="#">Morphology Core</a>	National Jewish Medical and Research Center	Ling-Yi Chang, Ph.D.	Stacey Katz	none	none	<a href="#">Highlighted</a>
65	R827997	<a href="#">A Source-Oriented Evaluation of the Combined Effects of Fine Particles and Copollutants</a>	Nelson Institute of Environ. Medicine, New York University School of Medicine	Kazuhiko Ito and George D. Thurston	Deran Pashayan	\$478,522	02/18/2000 to 02/17/2004	<a href="#">Highlighted</a>
66	R827993	<a href="#">Relationship Between PM2.5 Semi-volatile Organic Material, Other PM2.5 Components and Heart Rate Variability in The Elderly</a>	Brigham Young University	Delbert J. Eatough, C. Arden Pope III	Deran Pashayan	\$797,013	02/01/2000 to 01/31/2003	<a href="#">Highlighted</a>
67	none	<a href="#">Pollutant Fluxes to Aquatic Systems via Coupled Biological and Physicochemical Bed-Sediment Processes</a>	Louisiana State University	D. D. Reible, K. T. Valsaraj, L. J. Thibodeaux, J.W. Fleeger	none	none	none	<a href="#">Highlighted</a>





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## TITLE

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R826244	<a href="#">Mechanism of PM-Induced Acute Health Effects</a>	New York University Medical Center	Terry Gordon	Deran Pashayan	\$600,799	January 23, 1998 - January 22, 2,001	<a href="#">Highlighted</a>
2	R827355C005	<a href="#">Mechanisms of Toxicity of PM Using Transgenic Mouse Strains</a>	University of Washington	Daniel Luchtel, Timothy Larson; Consultants: Warren Ladiges, Joellen Lewtas	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
3	R827999	<a href="#">Acute Cardiopulmonary Responses to Fine Particulate Pollution and Copollutant Oxidant Gase in Los Angeles</a>	Rancho Los Amigos National Rehabilitation Center; University of Southern California	Henry Gong, Jr.; Constantinos Sioutas	Deran Pashayan	\$613,894	03/15/2000 to 03/14/2003	<a href="#">Highlighted</a>

	4	none	<a href="#"><u>Nickel-Induced Acute Lung Injury</u></a>	University of Cincinnati	Susan A. McDowell	Sheila Rosenthal	none	September 2000 - September 2003	<a href="#"><u>Highlighted</u></a>
	5	R827355	<a href="#"><u>Northwest Research Center for Particulate Air Pollution and Health University of Washington</u></a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#"><u>Highlighted</u></a>
	6	R827353C004	<a href="#"><u>Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</u></a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#"><u>Highlighted</u></a>
	7	R825264	<a href="#"><u>Acidic PM and Daily Human Mortality in Three U.S. Cities</u></a>	New York University Medical Center	George D. Thurston	Deran Pashayan	\$383,008	November 18, 1996 - November 17, 1999	<a href="#"><u>Highlighted</u></a>
	8	R826781	<a href="#"><u>Human Health Effects of Exposure to Ultrafine Particles</u></a>	University of Rochester School of Medicine and Dentistry	Mark W. Frampton, Mark J. Utell, Gunter Oberdorster, Victor Marder, Wojciech Zareba	Deran Pashayan	\$736,260	October 1, 1998 - September 30, 2001	<a href="#"><u>Highlighted</u></a>
	9	R827995	<a href="#"><u>Health Effects of Concentrated Ambient Particles from the Central Valley of California</u></a>	University of California, Davis; University of Southern California	Kent E. Pinkerton; Constantinos Sioutas	Deran Pashayan	\$633,328	02/01/2000 to 01/31/2003	<a href="#"><u>Highlighted</u></a>

	10	R827993	<a href="#">Relationship Between PM2.5 Semi-volatile Organic Material, Other PM2.5 Components and Heart Rate Variability in The Elderly</a>	Brigham Young University	Delbert J. Eatough, C. Arden Pope III	Deran Pashayan	\$797,013	02/01/2000 to 01/31/2003	<a href="#">Highlighted</a>
	11	R826778	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	Lovelace Biomedical and Environmental Research Institute (NM)	Janet M. Benson (PI), Edward B. Barr, David E. Bice, Yung-Sung Cheng, Joe L. Mauderly	Deran Pashayan	\$199,035	October 1, 1977 - September 30, 1999	<a href="#">Highlighted</a>
	12	R827352	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	University of California at Los Angeles; California Institute of Technology; Rancho Los Amigos Medical Center; University of California at Irvine; University of California at Riverside; University of Southern California	John R. Froines [jfroines@ucla.edu] (Center Director), Steven D. Colome (Co-Center Director) and Richard P. Turco (Co-Center Director), Arthur K. Cho, Yoram Cohen, Annmarie Eldering, Sheldon K. Friedlander, Stella C. Grosser, Oliver Hankinson, William C.	Stacey Katz	\$8,715,583	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

	13	R829213	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#">Highlighted</a>
	14	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30. 2001	<a href="#">Highlighted</a>
	15	R827354	<a href="#">Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</a>	University of Rochester; California Institute of Technology; University of California at Riverside; GSF - National Research Center for Environment & Health (Neuherberg, Germany); Research Triangle Institute; State University of New York at Buffalo; Univer	Gunter Oberdorster (Center Director), Mark Utell (Co-Center Director), William Beckett, Christopher Cox, Jacob Finkelstein, Mark Frampton, John Looney, Victor Marder, P. E. Morrow, Michael O'Reilly, Richard Phipps, Edward Schwarz, Barry Stripp and Wojciec	Gail Robarge	\$8,302,447	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
	16	R827997	<a href="#">A Source-Oriented Evaluation of the Combined Effects of Fine Particles and Copollutants</a>	Nelson Institute of Environ. Medicine, New York University School of Medicine	Kazuhiko Ito and George D. Thurston	Deran Pashayan	\$478,522	02/18/2000 to 02/17/2004	<a href="#">Highlighted</a>

	17	R827996	<a href="#"><u>Inhalability of Particulate Matter in Laboratory Animals</u></a>	Chemical Industry Institute of Toxicology	Bahman Asgharian	Daran Pashayan	\$335,903	01/17/2000 to 01/16/2002	<a href="#">Highlighted</a>
	18	R829215	<a href="#"><u>Health Effects of Airborne Particulate Matter and Gasses</u></a>	University of California, Davis, Davis, CA (1); University of Utah, Salt Lake City, UT (2); and Utah State University, Logan, UT (3)	(3)	Stacey Katz/Gail Robarge	\$833,481	October 1, 2001 - September 30, 2004	<a href="#">Highlighted</a>
	19	R827351	<a href="#"><u>Health Risks of PM Components</u></a>	New York University School of Medicine; University of Iowa	Morton Lippmann [lippmann@charlotte.med.nyu.edu] (Center Director), Richard B. Schlesinger (Co-Center Director), Beverly S. Cohen, Terry Gordon, Joan Reibman, George D. Thurston, Lung Chi Chen, Kazuhiko K. Ito, Christine C. Nadziejko, Judith T. Zelikoff,M	Gail Robarge	\$8,076,438	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

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## Tabular Query Results of NCER Program and Solicitation Information

**31 Abstracts are listed**

**Your Query was:**

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Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R826724	<a href="#">Mechanisms Of Particulate-Induced Allergic Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Marsha Wills-Karp, Ph.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>

	2	R826779	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	Harvard University	Lester Kobzik, Petros Koutrakis, Stephanie Shore, Beatriz Gonzalez-Flecha	Deran Pashayan	\$557,340	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	3	R825275	<a href="#">Asthma Indices Associated with Ambient Submicron Particles and Formaldehyde in Ambient Air Pollution</a>	National Jewish Medical and Research Center	Kevin P. Fennelly	Deran Pashayan	\$178,865	December 1, 1996 - November 30, 1997	<a href="#">Highlighted</a>
	4	R827355C002	<a href="#">Health Effects of PM in Susceptible Populations</a>	University of Washington	Jane Q. Koenig, Joel Kaufman, Carol Trenga, Jeff Sullivan, Sally Liu, Tim Larson, Lianne Sheppard, Thomas Lumley, Karen Jansen	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	5	R825702	<a href="#">Indoor-Outdoor Relationships of Airborne Particle Count and Endotoxin Concentrations</a>	National Jewish Medical and Research Center	Kevin P. Fennelly, MD, MPH	Stacey Katz	none	none	<a href="#">Highlighted</a>
	6	R826785	<a href="#">Effects of Inhaled Ultrafine Particles on Asthma</a>	Lovelace Respiratory Research Institute, Albuquerque, NM.	David E. Bice, T.K. Redman, K.J. Nikula, E.B. Barr, Y.S. Cheng	Deran Pashayan	\$545,147	October 1, 1998 September 30, 2001	<a href="#">Highlighted</a>

	7	R829216	<a href="#">Effects of Airborne Particles on Allergic Airway Disease</a>	(1)Michigan State University, East Lansing, MI; (2)University of Southern California and the Southern California Particle Center and Supersite, Los Angeles, CA	Jack Harkema, DVM, Ph.D., (PI) [harkemaj@msu.edu](1); Constantinos Sioutas, Ph.D. (Co-PI)(2)	Gail Robarge/Stacey Katz	\$854,702	October 31, 2001 - October 30, 2004	<a href="#">Highlighted</a>
	8	R827027	<a href="#">Research on Asthma</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	9	R825702	<a href="#">Inhalation of Particulate Matter Alters the Allergic Airway Response to Inhaled Allergen</a>	National Jewish Medical and Research Center	Erwin Gelfand, M.D., Larry Borish, M.D.	Stacey Katz	none	none	<a href="#">Highlighted</a>
	10	R824790	<a href="#">Cellular Mechanisms of Pulmonary Inflammation by Environmental Particles</a>	Harvard School of Public Health	Lester Kobzik, M.D.	Deran Pashayan	\$546,895	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
	11	R827355C005	<a href="#">Mechanisms of Toxicity of PM Using Transgenic Mouse Strains</a>	University of Washington	Daniel Luchtel, Timothy Larson; Consultants: Warren Ladiges, Joellen Lewtas	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

	12	R826724	<a href="#">A Randomized, Controlled Trial of Home Exposure Control in Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Peyton A. Eggleston, M.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	13	R827027	<a href="#">Growth and Development: Prenatal Exposure PAH</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	14	R825264	<a href="#">Acidic PM and Daily Human Mortality in Three U.S. Cities</a>	New York University Medical Center	George D. Thurston	Deran Pashayan	\$383,008	November 18, 1996 - November 17, 1999	<a href="#">Highlighted</a>
	15	R826781	<a href="#">Human Health Effects of Exposure to Ultrafine Particles</a>	University of Rochester School of Medicine and Dentistry	Mark W. Frampton, Mark J. Utell, Gunter Oberdorster, Victor Marder, Wojciech Zareba	Deran Pashayan	\$736,260	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	16	R826778	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	Lovelace Biomedical and Environmental Research Institute (NM)	Janet M. Benson (PI), Edward B. Barr, David E. Bice, Yung-Sung Cheng, Joe L. Mauderly	Deran Pashayan	\$199,035	October 1, 1977 - September 30, 1999	<a href="#">Highlighted</a>

	17	R829213	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#">Highlighted</a>
	18	R829214	<a href="#">Mechanisms of Air Pollutant-induced Pulmonary Inflammation; Effects of Zinc on EGFR Receptor Function</a>	University of North Carolina, Chapel Hill, NC	Lee M. Graves (lmg@med.unc.edu), Weidong Wu	Gail Robarge/Stacey Katz	\$874,125	November 19, 2001 - November 18, 2004	<a href="#">Highlighted</a>
	19	R826782	<a href="#">Airborne Particulate Matter-Induced Lung Inflammation</a>	University of Texas Houston Health Science Center	Andrij Holian, Maria T. Morandi, Edwin Parsley	Deran Pashayan	\$674,288	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>

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**21 Abstracts are listed**

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Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R826779	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	Harvard University	Lester Kobzik, Petros Koutrakis, Stephanie Shore, Beatriz Gonzalez-Flecha	Deran Pashayan	\$557,340	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
2	R827351	<a href="#">Health Risks of PM Components</a>	New York University School of Medicine; University of Iowa	Morton Lippmann [lippmann@charlotte.med.nyu.edu] (Center Director), Richard B. Schlesinger (Co-Center Director), Beverly S. Cohen, Terry Gordon, Joan Reibman, George D. Thurston, Lung Chi Chen, Kazuhiko K. Ito, Christine C. Nadziejko, Judith T. Zelikoff,M	Gail Robarge	\$8,076,438	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

	3	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30. 2001	<a href="#">Highlighted</a>
	4	R826724	<a href="#">Mechanisms Of Particulate-Induced Allergic Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Marsha Wills-Karp, Ph.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	5	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	6	R827353C005	<a href="#">Assessing Life-Shortening Associated with Exposure to Particulate Matter</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
	7	R827355	<a href="#">Northwest Research Center for Particulate Air Pollution and Health University of Washington</a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

	8	R829216	<a href="#">Effects of Airborne Particles on Allergic Airway Disease</a>	(1)Michigan State University, East Lansing, MI; (2)University of Southern California and the Southern California Particle Center and Supersite, Los Angeles, CA	Jack Harkema, DVM, Ph.D., (PI) [harkemaj@msu.edu](1); Constantinos Sioutas, Ph.D. (Co-PI)(2)	Gail Robarge/Stacey Katz	\$854,702	October 31, 2001 - October 30, 2004	<a href="#">Highlighted</a>
	9	R827355C002	<a href="#">Health Effects of PM in Susceptible Populations</a>	University of Washington	Jane Q. Koenig, Joel Kaufman, Carol Trenga, Jeff Sullivan, Sally Liu, Tim Larson, Lianne Sheppard, Thomas Lumley, Karen Jansen	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	10	R827352	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	University of California at Los Angeles; California Institute of Technology; Rancho Los Amigos Medical Center; University of California at Irvine; University of California at Riverside; University of Southern California	John R. Froines [jfroines@ucla.edu] (Center Director), Steven D. Colome (Co-Center Director) and Richard P. Turco (Co-Center Director), Arthur K. Cho, Yoram Cohen, Annmarie Eldering, Sheldon K. Friedlander, Stella C. Grosser, Oliver Hankinson, William C.	Stacey Katz	\$8,715,583	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
	11	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	Harvard University	John Godleski	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

	12	R825266	<a href="#">Air Pollution and Hospital Admissions in Washington State</a>	Fred Hutchinson Cancer Research Center	Suresh H. Moolgavkar	Deran Pashayan	\$420,056	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
	13	R825265	<a href="#">Ultrafine Particles in Urban and Respiratory Health Among Children with Respiratory Symptoms</a>	Harvard University	Joel Schwartz	Deran Pashayan	\$196,185	December 2, 1996 - December 1, 1999	<a href="#">Highlighted</a>
	14	R829213	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#">Highlighted</a>
	15	R827353	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	Harvard University	Petros Koutrakis [petros@hsph.harvard.edu] (Center Director), John J. Godleski, (Center Co-Director), Joel Schwartz, (Center Co-Director), Douglas W. Dockery, Frank E. Speizer, Helen H. Suh, Diane R. Gold, Richard L. Verrier, James Ware, Paul Catalano, Jo	Stacey Katz	\$7,747,040	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	16	R827027	<a href="#">Research on Asthma</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	17	R827027	<a href="#">Growth and Development: Prenatal Exposure PAH</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>

	18	R829215	<a href="#">Health Effects of Airborne Particulate Matter and Gasses</a>	University of California, Davis, Davis, CA (1); University of Utah, Salt Lake City, UT (2); and Utah State University, Logan, UT (3)	(3)	Stacey Katz/Gail Robarge	\$833,481	October 1, 2001 - September 30, 2004	<a href="#">Highlighted</a>
	19	R826724	<a href="#">A Randomized, Controlled Trial of Home Exposure Control in Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Peyton A. Eggleston, M.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	20	R826786	<a href="#">Characterization of Factors Determining Personal Exposure to Volatile Air Toxics in Urban Environments</a>	University of Oklahoma Health Sciences Center	N.A. Esmen, T.A. Hall, D.L. Johnson, and M.L. Phillips	Deran Pashayan	\$559,352	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	21	R827027	<a href="#">Community-Based Intervention: Reducing Risks of Asthma</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>

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## Tabular Query Results of NCER Program and Solicitation Information

**20 Abstracts are listed**

**Your Query was:**

**(PM <or> particulate) <and> (chronic) <and> <not> (R825551 <or> eutrophication of coral reefs)**

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R826782	<a href="#">Airborne Particulate Matter-Induced Lung Inflammation</a>	University of Texas Houston Health Science Center	Andrij Holian, Maria T. Morandi, Edwin Parsley	Deran Pashayan	\$674,288	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
2	R827353C006	<a href="#">Investigating Chronic Effects of Exposure to Particulate Matter</a>	Harvard University	Douglas Dockery	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>

	3	R827353C005	<a href="#">Assessing Life-Shortening Associated with Exposure to Particulate Matter</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
	4	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	Harvard University	John Godleski	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	5	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	6	R826270	<a href="#">Mechanisms of Particulate-Induced Mediator Expression in Human Airway Epithelial Cells</a>	University of North Carolina at Chapel Hill	William Reed, Lee M. Graves	Deran Pashayan	\$374,170	December 15, 1997 - December 14, 2000	<a href="#">Highlighted</a>
	7	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30. 2001	<a href="#">Highlighted</a>
	8	R827355C003	<a href="#">Personal PM Exposure Assessment</a>	University of Washington, Washington State University	L-J Sally Liu, Candis Claiborn, Lara Gundel, Timothy Larson	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	9	R827355C002	<a href="#">Health Effects of PM in Susceptible Populations</a>	University of Washington	Jane Q. Koenig, Joel Kaufman, Carol Trenga, Jeff Sullivan, Sally Liu, Tim Larson, Lianne Sheppard, Thomas Lumley, Karen Jansen	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

10	R827355C005	<a href="#">Mechanisms of Toxicity of PM Using Transgenic Mouse Strains</a>	University of Washington	Daniel Luchtel, Timothy Larson; Consultants: Warren Ladiges, Joellen Lewtas	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
11	R825702	<a href="#">Environment/Genetics in Beryllium Disease</a>	National Jewish Medical and Research Center	Lee S. Newman, M.D., M.A.; Lisa Maier, M.D.	Stacey Katz	none	none	<a href="#">Highlighted</a>
12	R827999	<a href="#">Acute Cardiopulmonary Responses to Fine Particulate Pollution and Copollutant Oxidant Gase in Los Angeles</a>	Rancho Los Amigos National Rehabilitation Center; University of Southern California	Henry Gong, Jr.; Constantinos Sioutas	Deran Pashayan	\$613,894	03/15/2000 to 03/14/2003	<a href="#">Highlighted</a>
13	R827353	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	Harvard University	Petros Koutrakis [petros@hsph.harvard.edu] (Center Director), John J. Godleski, (Center Co-Director), Joel Schwartz, (Center Co-Director), Douglas W. Dockery, Frank E. Speizer, Helen H. Suh, Diane R. Gold, Richard L. Verrier, James Ware, Paul Catalano, Jo	Stacey Katz	\$7,747,040	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
14	R827355	<a href="#">Northwest Research Center for Particulate Air Pollution and Health University of Washington</a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

15	R829216	<a href="#">Effects of Airborne Particles on Allergic Airway Disease</a>	(1)Michigan State University, East Lansing, MI; (2)University of Southern California and the Southern California Particle Center and Supersite, Los Angeles, CA	Jack Harkema, DVM, Ph.D., (PI) [harkemaj@msu.edu](1); Constantinos Sioutas, Ph.D. (Co-PI)(2)	Gail Robarge/Stacey Katz	\$854,702	October 31, 2001 - October 30, 2004	<a href="#">Highlighted</a>
16	R829213	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#">Highlighted</a>
17	R827353C001	<a href="#">Assessing Human Exposures to Particulate and Gaseous Air Pollutants</a>	Harvard University	Petros Koutrakis	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
18	R827353C003	<a href="#">Differentiating Health Effects of Particles from Outdoor and Indoor Sources</a>	Harvard University	Diane Gold, Peter Stone	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

19	R827352	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	University of California at Los Angeles; California Institute of Technology; Rancho Los Amigos Medical Center; University of California at Irvine; University of California at Riveside; University of Southern California	John R. Froines [jfroines@ucla.edu] (Center Director), Steven D. Colome (Co-Center Director) and Richard P. Turco (Co-Center Director), Arthur K. Cho, Yoram Cohen, Annmarie Eldering, Sheldon K. Friedlander, Stella C. Grosser, Oliver Hankinson, William C.	Stacey Katz	\$8,715,583	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
20	R827354	<a href="#">Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</a>	University of Rochester; California Institute of Technology; University of California at Riverside; GSF - National Research Center for Environment & Health (Neuherberg, Germany); Research Triangle Institute; State University of New York at Buffalo; Univer	Gunter Oberdorster (Center Director), Mark Utell (Co-Center Director), William Beckett, Christopher Cox, Jacob Finkelstein, Mark Frampton, John Looney, Victor Marder, P. E. Morrow, Michael O'Reilly, Richard Phipps, Edward Schwarz, Barry Stripp and Wojciec	Gail Robarge	\$8,302,447	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

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## **Tabular Query Results of NCER Program and Solicitation Information**

**4 Abstracts are listed**

**Your Query was:**

**(PM <or> particulate) <and> (diabet\*)**

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?

1	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
2	R827353C005	<a href="#">Assessing Life-Shortening Associated with Exposure to Particulate Matter</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
3	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	Harvard University	John Godleski	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
4	R827353	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	Harvard University	Petros Koutrakis [petros@hsph.harvard.edu] (Center Director), John J. Godleski, (Center Co-Director), Joel Schwartz, (Center Co-Director), Douglas W. Dockery, Frank E. Speizer, Helen H. Suh, Diane R. Gold, Richard L. Verrier, James Ware, Paul Catalano, Jo	Stacey Katz	\$7,747,040	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

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**9 Abstracts are listed**

**Your Query was:**

**(PM <or> particulate) <and> (dosimetry)**

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R827355C004	<a href="#">Dosimetry Assessment: Aerosol Number, Size Distribution, and Dosimetry Measurements and Modeling</a>	University of Washington	David S. Covert, Timothy Larson, Eugene Kim, Rob Elleman	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

	2	R827996	<a href="#"><u>Inhalability of Particulate Matter in Laboratory Animals</u></a>	Chemical Industry Institute of Toxicology	Bahman Asgharian	Deran Pashayan	\$335,903	01/17/2000 to 01/16/2002	<a href="#"><u>Highlighted</u></a>
	3	R827355	<a href="#"><u>Northwest Research Center for Particulate Air Pollution and Health</u></a> <a href="#"><u>University of Washington</u></a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#"><u>Highlighted</u></a>
	4	R827352	<a href="#"><u>Southern California Center for Airborne Particulate Matter (SCCAMP)</u></a>	University of California at Los Angeles; California Institute of Technology; Rancho Los Amigos Medical Center; University of California at Irvine; University of California at Riverside; University of Southern California	John R. Froines [jfroines@ucla.edu] (Center Director), Steven D. Colome (Co-Center Director) and Richard P. Turco (Co-Center Director), Arthur K. Cho, Yoram Cohen, Annmarie Eldering, Sheldon K. Friedlander, Stella C. Grosser, Oliver Hankinson, William C.	Stacey Katz	\$8,715,583	June 1, 1999 - May 30, 2004	<a href="#"><u>Highlighted</u></a>

	5	R827353C010	<a href="#">Relating Changes in Blood Viscosity, Other Clotting Parameters, Heart Rate, and Heart Rate Variability to Particulate and Criteria Gas Exposures</a>	Harvard University	Frank Speizer	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	6	R826781	<a href="#">Human Health Effects of Exposure to Ultrafine Particles</a>	University of Rochester School of Medicine and Dentistry	Mark W. Frampton, Mark J. Utell, Gunter Oberdorster, Victor Marder, Wojciech Zareba	Deran Pashayan	\$736,260	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	7	R827353	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	Harvard University	Petros Koutrakis [petros@hsph.harvard.edu] (Center Director), John J. Godleski, (Center Co-Director), Joel Schwartz, (Center Co-Director), Douglas W. Dockery, Frank E. Speizer, Helen H. Suh, Diane R. Gold, Richard L. Verrier, James Ware, Paul Catalano, Jo	Stacey Katz	\$7,747,040	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	8	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	Harvard University	John Godleski	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

9	R827351	<a href="#">Health Risks of PM Components</a>	New York University School of Medicine; University of Iowa	Morton Lippmann [lippmann@charlotte.med.nyu.edu] (Center Director), Richard B. Schlesinger (Co-Center Director), Beverly S. Cohen, Terry Gordon, Joan Reibman, George D. Thurston, Lung Chi Chen, Kazuhiko K. Ito, Christine C. Nadziejko, Judith T. Zelikoff,M	Gail Robarge	\$8,076,438	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
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## Tabular Query Results of NCER Program and Solicitation Information

**14 Abstracts are listed**

**Your Query was:**

**(PM <or> particulate) <and> (elderly)**

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R826783	<a href="#">Relationship of Ambient Particulate Matter to Heart Rate Variability and Cardiac Arrhythmias in Elderly Adults with Coronary Artery Disease</a>	California Office of Environmental Health Hazard Assessment (1), University of California (UC), San Francisco (2), UC Berkeley (3), UC Los Angeles (4), Eisenhower	Bart Ostro (1), Michael Lipsett (1), (2), Ira Tager (3), Mary Woo (4), Merle Bolton (5)	Deran Pashayan	\$436,964	October 1, 1998 September 30, 2000	<a href="#">Highlighted</a>

			Medical Center, Rancho Mirage, CA (5)					
2	R827993	<a href="#">Relationship Between PM2.5 Semi-volatile Organic Material, Other PM2.5 Components and Heart Rate Variability in The Elderly</a>	Brigham Young University	Delbert J. Eatough, C. Arden Pope III	Deran Pashayan	\$797,013	02/01/2000 to 01/31/2003	<a href="#">Highlighted</a>
3	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
4	R827998	<a href="#">Health Effects of long-Term Exposure to Particles and Other Air Pollutants in Elderly Nonsmoking California Residents</a>	Loma Linda University	Synnove F. Knutsen, David E Abbey and Larry Beeson	Deran Pashayan	\$763,910	March 1, 2000 -- February 28, 2003	<a href="#">Highlighted</a>
5	R826784	<a href="#">Lung Injury from Inhaled Ultrafine Particles in Compromised Rats of Old Age: Influence of Priming and Adaptation</a>	University of Rochester (NY)	Günter Oberdörster and Jacob N. Finkelstein	Deran Pashayan	\$606,545	September 21, 1998 September 20, 2001	<a href="#">Highlighted</a>

	6	R827999	<a href="#">Acute Cardiopulmonary Responses to Fine Particulate Pollution and Copollutant Oxidant Gase in Los Angeles</a>	Rancho Los Amigos National Rehabilitation Center; University of Southern California	Henry Gong, Jr.; Constantinos Sioutas	Deran Pashayan	\$613,894	03/15/2000 to 03/14/2003	<a href="#">Highlighted</a>
	7	R826780	<a href="#">Cardiovascular Vulnerability to Particulate Pollution</a>	Harvard School of Public Health	Diane R. Gold, Peter Stone, Augusto Litonjua; Richard Verrier, Joel Schwartz	Deran Pashayan	\$648,227	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	8	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30. 2001	<a href="#">Highlighted</a>
	9	R827997	<a href="#">A Source-Oriented Evaluation of the Combined Effects of Fine Particles and Copollutants</a>	Nelson Institute of Environ. Medicine, New York University School of Medicine	Kazuhiko Ito and George D. Thurston	Deran Pashayan	\$478,522	02/18/2000 to 02/17/2004	<a href="#">Highlighted</a>
	10	R825264	<a href="#">Acidic PM and Daily Human Mortality in Three U.S. Cities</a>	New York University Medical Center	George D. Thurston	Deran Pashayan	\$383,008	November 18, 1996 - November 17, 1999	<a href="#">Highlighted</a>
	11	R828046	<a href="#">Pulmonary and Systemic Effects of Inhaled Ultrafine Particles in Senescent Rats with Cardiovascular Disease</a>	University of Rochester	Alison C.P. Elder, Jean-Philippe Couderc, Mark Frampton, G <sup>3</sup> nter Oberdörster, Wojciech Zareba	Deran Pashayan	\$408,859	March 24, 2000 - March 23,2003	<a href="#">Highlighted</a>

	12	R829213	<a href="#"><u>Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</u></a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#"><u>Highlighted</u></a>
	13	R827355	<a href="#"><u>Northwest Research Center for Particulate Air Pollution and Health University of Washington</u></a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#"><u>Highlighted</u></a>
	14	R827354	<a href="#"><u>Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</u></a>	University of Rochester; California Institute of Technology; University of California at Riverside; GSF - National Research Center for Environment & Health (Neuherberg, Germany); Research Triangle Institute; State University of New York at Buffalo; Univer	Gunter Oberdorster (Center Director), Mark Utell (Co-Center Director), William Beckett, Christopher Cox, Jacob Finkelstein, Mark Frampton, John Looney, Victor Marder, P. E. Morrow, Michael O'Reilly, Richard Phipps, Edward Schwarz, Barry Stripp and Wojciec	Gail Robarge	\$8,302,447	June 1, 1999 - May 30, 2004	<a href="#"><u>Highlighted</u></a>

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## Tabular Query Results of NCER Program and Solicitation Information

**19 Abstracts are listed**

**Your Query was:**

**(PM <or> particulate) <and> (asthma) <and> <not> (administrative core)**

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R826724	<a href="#">Mechanisms Of Particulate-Induced Allergic Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Marsha Wills-Karp, Ph.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>

	2	R826779	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	Harvard University	Lester Kobzik, Petros Koutrakis, Stephanie Shore, Beatriz Gonzalez-Flecha	Deran Pashayan	\$557,340	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	3	R825275	<a href="#">Asthma Indices Associated with Ambient Submicron Particles and Formaldehyde in Ambient Air Pollution</a>	National Jewish Medical and Research Center	Kevin P. Fennelly	Deran Pashayan	\$178,865	December 1, 1996 - November 30, 1997	<a href="#">Highlighted</a>
	4	R827355C002	<a href="#">Health Effects of PM in Susceptible Populations</a>	University of Washington	Jane Q. Koenig, Joel Kaufman, Carol Trenga, Jeff Sullivan, Sally Liu, Tim Larson, Lianne Sheppard, Thomas Lumley, Karen Jansen	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	5	R825702	<a href="#">Indoor-Outdoor Relationships of Airborne Particle Count and Endotoxin Concentrations</a>	National Jewish Medical and Research Center	Kevin P. Fennelly, MD, MPH	Stacey Katz	none	none	<a href="#">Highlighted</a>
	6	R826785	<a href="#">Effects of Inhaled Ultrafine Particles on Asthma</a>	Lovelace Respiratory Research Institute, Albuquerque, NM.	David E. Bice, T.K. Redman, K.J. Nikula, E.B. Barr, Y.S. Cheng	Deran Pashayan	\$545,147	October 1, 1998 September 30, 2001	<a href="#">Highlighted</a>

	7	R829216	<a href="#">Effects of Airborne Particles on Allergic Airway Disease</a>	(1)Michigan State University, East Lansing, MI; (2)University of Southern California and the Southern California Particle Center and Supersite, Los Angeles, CA	Jack Harkema, DVM, Ph.D., (PI) [harkemaj@msu.edu](1); Constantinos Sioutas, Ph.D. (Co-PI)(2)	Gail Robarge/Stacey Katz	\$854,702	October 31, 2001 - October 30, 2004	<a href="#">Highlighted</a>
	8	R827027	<a href="#">Research on Asthma</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	9	R825702	<a href="#">Inhalation of Particulate Matter Alters the Allergic Airway Response to Inhaled Allergen</a>	National Jewish Medical and Research Center	Erwin Gelfand, M.D., Larry Borish, M.D.	Stacey Katz	none	none	<a href="#">Highlighted</a>
	10	R824790	<a href="#">Cellular Mechanisms of Pulmonary Inflammation by Environmental Particles</a>	Harvard School of Public Health	Lester Kobzik, M.D.	Deran Pashayan	\$546,895	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
	11	R827355C005	<a href="#">Mechanisms of Toxicity of PM Using Transgenic Mouse Strains</a>	University of Washington	Daniel Luchtel, Timothy Larson; Consultants: Warren Ladiges, Joellen Lewtas	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

	12	R826724	<a href="#">A Randomized, Controlled Trial of Home Exposure Control in Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Peyton A. Eggleston, M.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	13	R827027	<a href="#">Growth and Development: Prenatal Exposure PAH</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	14	R825264	<a href="#">Acidic PM and Daily Human Mortality in Three U.S. Cities</a>	New York University Medical Center	George D. Thurston	Deran Pashayan	\$383,008	November 18, 1996 - November 17, 1999	<a href="#">Highlighted</a>
	15	R826781	<a href="#">Human Health Effects of Exposure to Ultrafine Particles</a>	University of Rochester School of Medicine and Dentistry	Mark W. Frampton, Mark J. Utell, Gunter Oberdorster, Victor Marder, Wojciech Zareba	Deran Pashayan	\$736,260	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	16	R826778	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	Lovelace Biomedical and Environmental Research Institute (NM)	Janet M. Benson (PI), Edward B. Barr, David E. Bice, Yung-Sung Cheng, Joe L. Mauderly	Deran Pashayan	\$199,035	October 1, 1977 - September 30, 1999	<a href="#">Highlighted</a>

	17	R829213	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#">Highlighted</a>
	18	R829214	<a href="#">Mechanisms of Air Pollutant-induced Pulmonary Inflammation; Effects of Zinc on EGFR Receptor Function</a>	University of North Carolina, Chapel Hill, NC	Lee M. Graves (lmg@med.unc.edu), Weidong Wu	Gail Robarge/Stacey Katz	\$874,125	November 19, 2001 - November 18, 2004	<a href="#">Highlighted</a>
	19	R826782	<a href="#">Airborne Particulate Matter-Induced Lung Inflammation</a>	University of Texas Houston Health Science Center	Andrij Holian, Maria T. Morandi, Edwin Parsley	Deran Pashayan	\$674,288	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>

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## Tabular Query Results of NCER Program and Solicitation Information

**66 Abstracts are listed**

**Your Query was:**

**(PM <or> particulate) <and> (epidem\*<or> mortality <or> morbidity)**

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R826244	<a href="#">Mechanism of PM-Induced Acute Health Effects</a>	New York University Medical Center	Terry Gordon	Deran Pashayan	\$600,799	January 23, 1998 - January 22, 2,001	<a href="#">Highlighted</a>
2	R825264	<a href="#">Acidic PM and Daily Human Mortality in Three U.S. Cities</a>	New York University Medical Center	George D. Thurston	Deran Pashayan	\$383,008	November 18, 1996 - November 17, 1999	<a href="#">Highlighted</a>
3	R825367	<a href="#">Continuous Measurement of PM2.5 and Associated Semi-Volatile Particulate Species</a>	Brigham Young University	Delbert J. Eatough	Bill Stelz	\$353,103	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>

4	R825268	<a href="#">Pulmonary Toxicity of Particulate Matter and Ozone</a>	New York University Medical Center	Lung Chi Chen	Deran Pashayan	\$172,446	November 18, 1996 - November 17, 1998	<a href="#">Highlighted</a>
5	R826779	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	Harvard University	Lester Kobzik, Petros Koutrakis, Stephanie Shore, Beatriz Gonzalez-Flecha	Deran Pashayan	\$557,340	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
6	R827351	<a href="#">Health Risks of PM Components</a>	New York University School of Medicine; University of Iowa	Morton Lippmann [lippmann@charlotte.med.nyu.edu] (Center Director), Richard B. Schlesinger (Co-Center Director), Beverly S. Cohen, Terry Gordon, Joan Reibman, George D. Thurston, Lung Chi Chen, Kazuhiko K. Ito, Christine C. Nadziejko, Judith T. Zelikoff,M	Gail Robarge	\$8,076,438	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
7	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30. 2001	<a href="#">Highlighted</a>
8	R826782	<a href="#">Airborne Particulate Matter-Induced Lung Inflammation</a>	University of Texas Houston Health Science Center	Andrij Holian, Maria T. Morandi, Edwin Parsley	Deran Pashayan	\$674,288	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
9	R826724	<a href="#">Mechanisms Of Particulate-Induced Allergic Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Marsha Wills-Karp, Ph.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>

10	R825267	<a href="#">Development of Population-Based Particle Exposure Models for Human Health Risk Assessment</a>	Harvard University	John D. Spengler	Deran Pashayan	\$500,065	December 2, 1996 - December 1, 1999	<a href="#">Highlighted</a>
11	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
12	R826780	<a href="#">Cardiovascular Vulnerability to Particulate Pollution</a>	Harvard School of Public Health	Diane R. Gold, Peter Stone, Augusto Litonjua; Richard Verrier, Joel Schwartz	Deran Pashayan	\$648,227	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
13	R827353C005	<a href="#">Assessing Life-Shortening Associated with Exposure to Particulate Matter</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
14	R827355	<a href="#">Northwest Research Center for Particulate Air Pollution and Health University of Washington</a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
15	R826245	<a href="#">The Relative Associations of Transition Metals and Sources of Fine Particulate Matter to Increased Daily Mortality</a>	Harvard University, School of Public Health	Joel Schwartz	Deran Pashayan	\$ 211,733	January 14, 1998 - January 13, 2,000	<a href="#">Highlighted</a>
16	R827353C006	<a href="#">Investigating Chronic Effects of Exposure to Particulate Matter</a>	Harvard University	Douglas Dockery	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>

	17	R829216	<a href="#">Effects of Airborne Particles on Allergic Airway Disease</a>	(1)Michigan State University, East Lansing, MI; (2)University of Southern California and the Southern California Particle Center and Supersite, Los Angeles, CA	Jack Harkema, DVM, Ph.D., (PI) [harkemaj@msu.edu](1); Constantinos Sioutas, Ph.D. (Co-PI)(2)	Gail Robarge/Stacey Katz	\$854,702	October 31, 2001 û October 30, 2004	<a href="#">Highlighted</a>
	18	R826270	<a href="#">Mechanisms of Particulate-Induced Mediator Expression in Human Airway Epithelial Cells</a>	University of North Carolina at Chapel Hill	William Reed, Lee M. Graves	Deran Pashayan	\$374,170	December 15, 1997 - December 14, 2000	<a href="#">Highlighted</a>
	19	R825242	<a href="#">Pathophysiologic Mechanisms of Mortality Associated with Exposure to Concentrated Particulate Urban Air Toxics</a>	Harvard University	John J. Godleski	Deran Pashayan	\$520,997	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
	20	R827355C001	<a href="#">Epidemiologic Study of Particulate Matter and Cardiopulmonary Mortality</a>	University of Washington	Joel Kaufman, Harvey Checkoway, Lianne Sheppard, David Siscovick, Jane Koenig	Joel Kaufman, Harvey Checkoway, Lianne Sheppard, David Siscovick, Jane Koenig	none	Gail Robarge/Stacey Katz	<a href="#">Highlighted</a>
	21	R827353C010	<a href="#">Relating Changes in Blood Viscosity, Other Clotting Parameters, Heart Rate, and Heart Rate Variability to Particulate and Criteria Gas Exposures</a>	Harvard University	Frank Speizer	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

22	R827353C001	<a href="#">Assessing Human Exposures to Particulate and Gaseous Air Pollutants</a>	Harvard University	Petros Koutrakis	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
23	R827997	<a href="#">A Source-Oriented Evaluation of the Combined Effects of Fine Particles and Copollutants</a>	Nelson Institute of Environ. Medicine, New York University School of Medicine	Kazuhiko Ito and George D. Thurston	Deran Pashayan	\$478,522	02/18/2000 to 02/17/2004	<a href="#">Highlighted</a>
24	R827999	<a href="#">Acute Cardiopulmonary Responses to Fine Particulate Pollution and Copollutant Oxidant Gase in Los Angeles</a>	Rancho Los Amigos National Rehabilitation Center; University of Southern California	Henry Gong, Jr.; Constantinos Sioutas	Deran Pashayan	\$613,894	03/15/2000 to 03/14/2003	<a href="#">Highlighted</a>
25	R828686	<a href="#">Spatial and Temporal Models for Environmental Health Effects</a>	Duke University, Durham, NC	Merlise Clyde (clyde@stat.duke.edu)	Chris Saint	\$557,859	February 12, 2001 - February 11, 2004	<a href="#">Highlighted</a>
26	R826783	<a href="#">Relationship of Ambient Particulate Matter to Heart Rate Variability and Cardiac Arrhythmias in Elderly Adults with Coronary Artery Disease</a>	California Office of Environmental Health Hazard Assessment (1), University of California (UC), San Francisco (2), UC Berkeley (3), UC Los Angeles (4), Eisenhower Medical Center, Rancho Mirage, CA (5)	Bart Ostro (1), Michael Lipsett (1), (2), Ira Tager (3), Mary Woo (4), Merle Bolton (5)	Deran Pashayan	\$436,964	October 1, 1998 September 30, 2000	<a href="#">Highlighted</a>

27	R827352	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	University of California at Los Angeles; California Institute of Technology; Rancho Los Amigos Medical Center; University of California at Irvine; University of California at Riverside; University of Southern California	John R. Froines [jfroines@ucla.edu] (Center Director), Steven D. Colome (Co-Center Director) and Richard P. Turco (Co-Center Director), Arthur K. Cho, Yoram Cohen, Annmarie Eldering, Sheldon K. Friedlander, Stella C. Grosser, Oliver Hankinson, William C.	Stacey Katz	\$8,715,583	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
28	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	Harvard University	John Godleski	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
29	R827353C002	<a href="#">Quantifying Exposure Error and its Effect on Epidemiological Studies</a>	Harvard University	Helen Suh	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
30	R826768	<a href="#">Modeling and Evaluation of Mechanisms Controlling the Outdoor/Indoor Relationships of Fine Particle Levels and Characteristics</a>	University of Medicine and Dentistry of New Jersey	Panos G. Georgopoulos	Paul Shapiro	\$170,828	October 1, 1998 - September 30, 2000	<a href="#">Highlighted</a>
31	R825266	<a href="#">Air Pollution and Hospital Admissions in Washington State</a>	Fred Hutchinson Cancer Research Center	Suresh H. Moolgavkar	Deran Pashayan	\$420,056	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>

32	R827353C003	<a href="#">Differentiating Health Effects of Particles from Outdoor and Indoor Sources</a>	Harvard University	Diane Gold, Peter Stone	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
33	R825275	<a href="#">Asthma Indices Associated with Ambient Submicron Particles and Formaldehyde in Ambient Air Pollution</a>	National Jewish Medical and Research Center	Kevin P. Fennelly	Deran Pashayan	\$178,865	December 1, 1996 - November 30, 1997	<a href="#">Highlighted</a>
34	R829213	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#">Highlighted</a>
35	R827355C005	<a href="#">Mechanisms of Toxicity of PM Using Transgenic Mouse Strains</a>	University of Washington	Daniel Luchtel, Timothy Larson; Consultants: Warren Ladiges, Joellen Lewtas	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
36	R825702	<a href="#">Indoor-Outdoor Relationships of Airborne Particle Count and Endotoxin Concentrations</a>	National Jewish Medical and Research Center	Kevin P. Fennelly, MD, MPH	Stacey Katz	none	none	<a href="#">Highlighted</a>
37	R824791	<a href="#">Distribution of H+ and Trace Metals in Ultrafine Ambient Aerosol</a>	New York University Medical Center	Beverly S. Cohen	Deran Pashayan	\$589,560	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
38	R826246	<a href="#">Particle Toxicity and the Respiratory Bronchiole</a>	University of California	Kent E. Pinkerton, Alan Buckpitt, Charles Plopper	Deran Pashayan	\$525,000	February 1, 1998 - January 31, 2001	<a href="#">Highlighted</a>

39	R827354	<a href="#">Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</a>	University of Rochester; California Institute of Technology; University of California at Riverside; GSF - National Research Center for Environment & Health (Neuherberg, Germany); Research Triangle Institute; State University of New York at Buffalo; Univer	Gunter Oberdorster (Center Director), Mark Utell (Co-Center Director), William Beckett, Christopher Cox, Jacob Finkelstein, Mark Frampton, John Looney, Victor Marder, P. E. Morrow, Michael O'Reilly, Richard Phipps, Edward Schwarz, Barry Stripp and Wojciec	Gail Robarge	\$8,302,447	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
40	R827353	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	Harvard University	Petros Koutrakis [petros@hsph.harvard.edu] (Center Director), John J. Godleski, (Center Co-Director), Joel Schwartz, (Center Co-Director), Douglas W. Dockery, Frank E. Speizer, Helen H. Suh, Diane R. Gold, Richard L. Verrier, James Ware, Paul Catalano, Jo	Stacey Katz	\$7,747,040	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
41	R828046	<a href="#">Pulmonary and Systemic Effects of Inhaled Ultrafine Particles in Senescent Rats with Cardiovascular Disease</a>	University of Rochester	Alison C.P. Elder, Jean-Philippe Couderc, Mark Frampton, Gunter Oberdorster, Wojciech Zareba	Deran Pashayan	\$408,859	March 24, 2000 - March 23,2003	<a href="#">Highlighted</a>
42	R826785	<a href="#">Effects of Inhaled Ultrafine Particles on Asthma</a>	Lovelace Respiratory Research Institute, Albuquerque, NM.	David E. Bice, T.K. Redman, K.J. Nikula, E.B. Barr, Y.S. Cheng	Deran Pashayan	\$545,147	October 1, 1998 September 30, 2001	<a href="#">Highlighted</a>

43	R825271	<a href="#">An Evaluation of Confounders in PM10/Mortality Associations</a>	New York University Medical Center	Kazuhiko Ito	Deran Pashayan	\$363,394	November 25, 1996 - November, 24, 1999	<a href="#">Highlighted</a>
44	R827994	<a href="#">Cardiovascular Responses to Particulate Air Pollution</a>	Pennsylvania State University; University of North Carolina at Chapel Hill	Duanping Liao, Vernon M. Chinchilli; Gerardo Heiss, Carl Shy	Deran Pashayan	\$607,630	January 2000 - January 2003	<a href="#">Highlighted</a>
45	R826232	<a href="#">Morphological and Chemical Characteristics of the Submicron Atmospheric Aerosol: Implication for Standards</a>	University of California, Los Angeles	Sheldon K. Friedlander	Paul Shapiro	\$345,247	January 2, 1998 - January 31, 2001	<a href="#">Highlighted</a>
46	R826784	<a href="#">Lung Injury from Inhaled Ultrafine Particles in Compromised Rats of Old Age: Influence of Priming and Adaptation</a>	University of Rochester (NY)	Günter Oberdörster and Jacob N. Finkelstein	Deran Pashayan	\$606,545	September 21, 1998 September 20, 2001	<a href="#">Highlighted</a>
47	R829214	<a href="#">Mechanisms of Air Pollutant-induced Pulmonary Inflammation: Effects of Zinc on EGFR Receptor Function</a>	University of North Carolina, Chapel Hill, NC	Lee M. Graves (lmg@med.unc.edu), Weidong Wu	Gail Robarge/Stacey Katz	\$874,125	November 19, 2001 ù November 18, 2004	<a href="#">Highlighted</a>
48	R827027	<a href="#">Growth and Development: Prenatal Exposure PAH</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>

49	U91-5361	<a href="#">Studies of Aerosol Composition, Partitioning and Heterogeneous Chemistry using Infrared Spectroscopy</a>	University of North Carolina at Chapel Hill	C Cindy DeForest Hauser	Georgette Boddie	22,978	8/16/98	<a href="#">Highlighted</a>
50	R826234	<a href="#">Real-time Measurement of the Size and Composition of Atmospheric Particulate Matter</a>	University of Delaware	Anthony S. Wexler	Paul Shapiro	\$374,833	December 15, 1997 - December 14, 2000	<a href="#">Highlighted</a>
51	R827998	<a href="#">Health Effects of long-Term Exposure to Particles and Other Air Pollutants in Elderly Nonsmoking California Residents</a>	Loma Linda University	Synnove F. Knutsen, David E Abbey and Larry Beeson	Deran Pashayan	\$763,910	March 1, 2000 -- February 28, 2003	<a href="#">Highlighted</a>
52	R829215	<a href="#">Health Effects of Airborne Particulate Matter and Gasses</a>	University of California, Davis, Davis, CA (1); University of Utah, Salt Lake City, UT (2); and Utah State University, Logan, UT (3)	(3)	Stacey Katz/Gail Robarge	\$833,481	October 1, 2001 - September 30, 2004	<a href="#">Highlighted</a>
53	R824790	<a href="#">Cellular Mechanisms of Pulmonary Inflammation by Environmental Particles</a>	Harvard School of Public Health	L Lester Kobzik, M.D.	Deran Pashayan	\$546,895	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
54	R825702	<a href="#">Particle-Induced Lung Inflammation and Extracellular EC-SOD</a>	National Jewish Medical and Research Center	J James D. Crapo, M.D., Ling-Yi Chang, Ph.D.	Stacey Katz	none	none	<a href="#">Highlighted</a>

55	R827355C003	<a href="#">Personal PM Exposure Assessment</a>	University of Washington, Washington State University	L-J Sally Liu, Candis Claiborn, Lara Gundel, Timothy Larson	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
56	R826724	<a href="#">A Randomized, Controlled Trial of Home Exposure Control in Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Peyton A. Eggleston, M.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
57	R828731	<a href="#">Implications of Climate Change for Regional Air Pollution, Health Effects and Energy Consumption Behavior</a>	The Johns Hopkins University, Baltimore, MD; George Washington University, Washington, DC	J.H. Ellis (PI-JHU) [hugh.ellis@jhu.edu], B.F. Hobbs (JHU), J.F. Patz (JHU), J. Samet (JHU), M. Schwab (JHU), F. Joutz (GW)	Bernice Smith	\$1,376,739	September 1, 2000 - August 31, 2003	<a href="#">Highlighted</a>
58	R825305	<a href="#">Development of a Continuous Monitoring System for PM10 and Components of PM2.5</a>	New York University Medical Center	Morton Lippmann	Bill Stelz	\$436,262	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
59	R826778	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	Lovelace Biomedical and Environmental Research Institute (NM)	Janet M. Benson (PI), Edward B. Barr, David E. Bice, Yung-Sung Cheng, Joe L. Mauderly	Deran Pashayan	\$199,035	October 1, 1977 - September 30, 1999	<a href="#">Highlighted</a>

60	R825702	<a href="#">Administrative Core</a>	National Jewish Medical and Research Center	Robert J. Mason, M.D.	Stacey Katz	none	none	<a href="#">Highlighted</a>
61	R828039	<a href="#">Detection of Emerging Microbial Contaminants in Source and Finished Drinking Water</a>	Battelle-Pacific Northwest Division, Environmental Microbiology Group, Richland, WA; Metropolitan Water District of Southern California, Water Quality Laboratory, La Verne, CA	Darrell P. Chandler and Ricardo De Leon	Cynthia L. Nolt-Helms	\$517,818	March 2000 - March 2003	<a href="#">Highlighted</a>
62	R826769	<a href="#">A Portable Device for Real-Time Measurement of the Size and Composition of Atmospheric Aerosols</a>	University of Delaware1; New Mexico State University2	Murray V. Johnston1 and Gary A. Eiceman2	Paul Shapiro	\$580,963	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
63	R827996	<a href="#">Inhalability of Particulate Matter in Laboratory Animals</a>	Chemical Industry Institute of Toxicology	Bahman Asgharian	Deran Pashayan	\$335,903	01/17/2000 to 01/16/2002	<a href="#">Highlighted</a>
64	R827993	<a href="#">Relationship Between PM2.5 Semi-volatile Organic Material, Other PM2.5 Components and Heart Rate Variability in The Elderly</a>	Brigham Young University	Delbert J. Eatough, C. Arden Pope III	Deran Pashayan	\$797,013	02/01/2000 to 01/31/2003	<a href="#">Highlighted</a>

65	none	<a href="#">Investigation of the Formation of Particulate Matter in Spark-Ignited Engines</a>	Massachusetts Institute of Technology	Simone Hochgreb and Arthur Lafleur	none	\$75,000.00	06/30/99 ending date	<a href="#">Highlighted</a>
66	none	<a href="#">Eutrophication of Coral Reefs</a>	none	Rafael A. Olivieri	none	none	none	<a href="#">Highlighted</a>

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## Tabular Query Results of NCER Program and Solicitation Information

**5 Abstracts are listed**

**Your Query was:**

**((particulate matter <or> pm) <and> (ambient air <or>air) <and> (monitor\* <or> measure\*))**

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	68D50095	<a href="#">Instrument for Monitoring Fine, Respirable Particulate Matter in Flue Gases</a>	Advanced Fuel Research, Inc.	Mr. James R. Markham	none	\$64,836	September 1995 - March 1996	<a href="#">Highlighted</a>
2	68D01008	<a href="#">Optical Monitor for Noninvasive, Chemical- and Size-Differentiated Characterization of Airborne Aerosols</a>	Air Instruments & Measurements, Inc.	Harry C. Lord III	none	\$69,783	April 2001 - September 2001	<a href="#">Highlighted</a>
3	68D99070	<a href="#">Development of a Real-Time In Situ Organic/Elemental Carbon (OC/EC) Analyzer</a>	Sunset Laboratory, Inc.	Mr. R.A. Cary	none	\$69,644	September 1999 - March 2000	<a href="#">Highlighted</a>
4	68D60057	<a href="#">Method for Direct Continuous Monitoring of Particulate Emissions from Industrial Effluents</a>	LSR Technologies, Inc.	Dr. Zhen Wu Lin	none	\$225,000	September 1996 - September 1998	<a href="#">Highlighted</a>

5	68D50089	<a href="#">Method for Direct Continuous Monitoring of Particulate Emissions from Industrial Effluents</a>	LSR Technologies, Inc.	Dr. Zhen Wu Lin	none	\$65,000	September 1995 - March 1996	<a href="#">Highlighted</a>
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## Tabular Query Results of NCER Program and Solicitation Information

**88 Abstracts are listed**

**Your Query was:**

((PM <or> particulate) <and> (ambient air <or> air) <and> (model))

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R825267	<a href="#">Development of Population-Based Particle Exposure Models for Human Health Risk Assessment</a>	Harvard University	John D. Spengler	Deran Pashayan	\$500,065	December 2, 1996 - December 1, 1999	<a href="#">Highlighted</a>
2	R824793	<a href="#">Development and Testing of a State-of-the-Art PMx Particulate Matter Module for Regional and Urban Air Pollution Models</a>	Carnegie Mellon University	Spyros N. Pandis	Deran Pashayan	\$412,041	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>

3	R826768	<a href="#">Modeling and Evaluation of Mechanisms Controlling the Outdoor/Indoor Relationships of Fine Particle Levels and Characteristics</a>	University of Medicine and Dentistry of New Jersey	Panos G. Georgopoulos	Paul Shapiro	\$170,828	October 1, 1998 - September 30, 2000	<a href="#">Highlighted</a>
4	R82-2S62	<a href="#">Characterizations of Motor Vehicle Emissions</a>	University of Nevada	Barbara Zielinska	none	\$201,731	2 years	<a href="#">Highlighted</a>
5	U91-5347	<a href="#">Characterization Of Indoor Particulate Source Strengths Using Continuous Mass And Size Monitors</a>	Harvard School of Public Health, Environmental Science & Engineering Program,	Christopher M. Long	Bernice Smith	34,000	9/8/98	<a href="#">Highlighted</a>
6	R825376	<a href="#">A Study of the Gas/Particle Partitioning of Chlorinated Dibenzodioxins (CDDs) and Chlorinated Dibenzofurans (CDFs) to Ambient and Model Aerosol Materials</a>	Oregon Grad. Inst. of Science & Technology	James F. Pankow	Paul Shapiro	\$466,448	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
7	R81-9732	<a href="#">Dry Deposition of Atmospheric Particles: Application of Current Models to Ambient Data</a>	Illinois Institute of Technology	Thomas M. Holsen	none	none	2 years	<a href="#">Highlighted</a>
8	R827355C005	<a href="#">Mechanisms of Toxicity of PM Using Transgenic Mouse Strains</a>	University of Washington	Daniel Luchtel, Timothy Larson; Consultants: Warren Ladiges, Joellen Lewtas	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

9	R825254	<a href="#">Development and Evaluation of a Shallow Convection Parameterization for Mesoscale Models</a>	Pennsylvania State University	Nelson Seaman	Paul Shapiro	\$449,000	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
10	R827997	<a href="#">A Source-Oriented Evaluation of the Combined Effects of Fine Particles and Copollutants</a>	Nelson Institute of Environ. Medicine, New York University School of Medicine	Kazuhiko Ito and George D. Thurston	Deran Pashayan	\$478,522	02/18/2000 to 02/17/2004	<a href="#">Highlighted</a>
11	R827352	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	University of California at Los Angeles; California Institute of Technology; Rancho Los Amigos Medical Center; University of California at Irvine; University of California at Riveside; University of Southern California	John R. Froines [jfroines@ucla.edu] (Center Director), Steven D. Colome (Co-Center Director) and Richard P. Turco (Co-Center Director), Arthur K. Cho, Yoram Cohen, Annmarie Eldering, Sheldon K. Friedlander, Stella C. Grosser, Oliver Hankinson, William C.	Stacey Katz	\$8,715,583	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
12	R829213	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#">Highlighted</a>

	13	R826236	<a href="#">RO<sub>2</sub> and HO<sub>x</sub> Radicals in Urban and Rural Air: Measurements of OH and RO<sub>2</sub> Formation From Ozone-Alkene Reactions, and the Rate Coefficients of the Reactions of High Molecular Weight RO<sub>2</sub> Radicals with HO<sub>2</sub></a>	University of California at Los Angeles	Suzanne Paulson, Stanley Sander	Paul Shapiro	\$440,323	January 15, 1998 - January 14, 2001	<a href="#">Highlighted</a>
	14	R827996	<a href="#">Inhalability of Particulate Matter in Laboratory Animals</a>	Chemical Industry Institute of Toxicology	Bahman Asgharian	Deran Pashayan	\$335,903	01/17/2000 to 01/16/2002	<a href="#">Highlighted</a>
	15	R827115	<a href="#">Modeling Collision Efficiencies for Coalescence of Small Drops and Particles</a>	Cornell University	Donald L. Koch	Paul Shapiro	\$305,155	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	16	R826233	<a href="#">The Contribution of Biomass Combustion to Ambient Fine Particle Concentrations in the United States</a>	California Institute of Technology	Glen R. Cass	Paul Shapiro	\$532,642	February 1, 1998 - January 31, 2001	<a href="#">Highlighted</a>
	17	R824796	<a href="#">A Study of Ozone Concentration Gradients in Large Buildings, Including an Examination of Indoor Chemistry, Ventilation, Occupant Health Effects and Effects on HVAC Systems</a>	Harvard University School of Public Health	John D. Spengler	Deran Pashayan	\$425,708	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>

	18	R828686	<a href="#">Spatial and Temporal Models for Environmental Health Effects</a>	Duke University, Durham, NC	Merlise Clyde (clyde@stat.duke.edu)	Chris Saint	\$557,859	February 12, 2001 - February 11, 2004	<a href="#">Highlighted</a>
	19	R825270	<a href="#">Development and Evaluation of a Novel Sampling Method to Determine the Phase Partitioning of Semi-Volatile Organic Compounds</a>	Harvard University	Petros Koutrakis, Constantinos Sioutas, Mike Wolfson, and Joy Lawrence	Paul Shapiro	\$409,507	December 1, 1996 - November 30, 1999	<a href="#">Highlighted</a>
	20	R827355C004	<a href="#">Dosimetry Assessment: Aerosol Number, Size Distribution, and Dosimetry Measurements and Modeling</a>	University of Washington	David S. Covert, Timothy Larson, Eugene Kim, Rob Elleman	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	21	R827353C010	<a href="#">Relating Changes in Blood Viscosity, Other Clotting Parameters, Heart Rate, and Heart Rate Variability to Particulate and Criteria Gas Exposures</a>	Harvard University	Frank Speizer	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	22	R823514	<a href="#">Formation and Physical Properties of Secondary Organic Aerosol</a>	Carnegie Mellon University	Spyros N. Pandis	Paul Shapiro	\$382,668	September 28, 1995 - September 27, 1998	<a href="#">Highlighted</a>
	23	R825247	<a href="#">Atmospheric Fate and Dry Deposition of Urban Soot to Great Waters Using a Novel, State-of-the-Art Isotopic Particulate Tracer</a>	University of Maryland	John M. Ondov	Deran Pashayan	\$454,976	December 6, 1996 - December 5, 1999	<a href="#">Highlighted</a>

	24	R826654	<a href="#">Development of a Novel Condensation Nuclei Counter and Application to Ultrafine Particle Formation</a>	Clarkson University1, Illinois Institute of Technology2	Philip K. Hopke1, Hwa-Chi Wang2	Paul Shapiro	\$393,657	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	25	R824970	<a href="#">Atmospheric Transformation of Volatile Organic Compounds: Gas-Phase Photooxidation and Gas-to-Particle Conversion</a>	California Institute of Technology	J. H. Seinfeld,R. C. Flagan	Paul Shapiro	\$300,000.00	05/31/97 ending date	<a href="#">Highlighted</a>
	26	R826235	<a href="#">Investigations of the Chemistry of Secondary Aerosol Formation Using Thermal Desorption Particle Beam Mass Spectrometry</a>	University of California, Riverside	Paul J. Ziemann	Paul Shapiro	\$294,762	December 1, 1997 - November 30, 2000	<a href="#">Highlighted</a>
	27	R826176	<a href="#">The First Robust RO2 Analyzer for Urban Air</a>	Portland State University	Thomas M. Hard	Paul Shapiro	\$355,290	January 1, 1998 - December 31, 2000	<a href="#">Highlighted</a>
	28	R828733	<a href="#">Modeling Heat and Air Quality Impacts of Changing Urban Land Uses and Climate</a>	Columbia University1, Montclair State University2, Rutgers University3, State University of NY at Albany4	Patrick L. Kinney1 (plk3@columbia.edu), William D. Soleki2, Roni Avissar3, S.T. Rao4, Christopher Small1	Bernice Smith	\$1,496,418	September 1, 2000 - August 31, 2003	<a href="#">Highlighted</a>

	29	R827355	<a href="#">Northwest Research Center for Particulate Air Pollution and Health University of Washington</a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
	30	R823328	<a href="#">Product Formation and Identification in Photodegradation of Polycyclic Aromatic Hydrocarbons in Models of Atmospheric Particulate: Effect of the Surface Physical and Chemical Properties</a>	University of Puerto Rico, San Juan, Puerto Rico	Rafael Arce and Osvaldo Rosario	Virginia Broadway	\$293,682	September 1995 - September 1998	<a href="#">Highlighted</a>
	31	U915841	<a href="#">The Influence of Clouds and the Marine Environment on Atmospheric Mercury Chemistry and Cycling</a>	University of Michigan	Elizabeth G. Malcolm	Charles Mitchell	none	December 2000 - December 2001	<a href="#">Highlighted</a>
	32	R826647	<a href="#">Quantification of the Dry Deposition Flux and Air Water Exchange of Reactive and Reduced Nitrogen</a>	Illinois Institute of Technology	Thomas M. Holsen	S. Bala Krishnan	\$309,104	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>

	33	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	Harvard University	John Godleski	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	34	R826773	<a href="#">A Modeling Investigation of NHx Cycling in the Troposphere and Its Impact on Particulate Matter and Acidic Substances Budgets</a>	MCNC-North Carolina Supercomputing Center	Rohit Mathur, Uma Shankar, Carlie J. Coats, John McHenry, and Marc Houyoux	Paul Shapiro	\$488,744	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	35	R826784	<a href="#">Lung Injury from Inhaled Ultrafine Particles in Compromised Rats of Old Age: Influence of Priming and Adaptation</a>	University of Rochester (NY)	Günter Oberdörster and Jacob N. Finkelstein	Deran Pashayan	\$606,545	September 21, 1998 September 20, 2001	<a href="#">Highlighted</a>
	36	R823419	<a href="#">Lagrangian Modeling of Pollutant Dispersal in the Atmospheric Boundary Layer</a>	CIRES, University of Colorado	Jeffrey C. Weil	Paul Shapiro	\$164,473	October 1, 1995 - September 30, 1997	<a href="#">Highlighted</a>
	37	none	<a href="#">Estimation of Indoor Particulate Matter Emissions in Large Office Buildings: A Preliminary Evaluation of EPAÆs BASE Study Data</a>	none	Adam C. Johnston	none	none	none	<a href="#">Highlighted</a>

38	R824790	<a href="#">Cellular Mechanisms of Pulmonary Inflammation by Environmental Particles</a>	Harvard School of Public Health	Lester Kobzik, M.D.	Deran Pashayan	\$546,895	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
39	R826782	<a href="#">Airborne Particulate Matter-Induced Lung Inflammation</a>	University of Texas Houston Health Science Center	Andrij Holian, Maria T. Morandi, Edwin Parsley	Deran Pashayan	\$674,288	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
40	R825271	<a href="#">An Evaluation of Confounders in PM10/Mortality Associations</a>	New York University Medical Center	Kazuhiko Ito	Deran Pashayan	\$363,394	November 25, 1996 - November, 24, 1999	<a href="#">Highlighted</a>
41	R825389	<a href="#">Optimization of In-Situ Capture by Sorbents of Toxic Metals in Combustion Processes</a>	University of Arizona	Jost O.L. Wendt	Paul Shapiro	\$293,068	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
42	R827351	<a href="#">Health Risks of PM Components</a>	New York University School of Medicine; University of Iowa	Morton Lippmann [lippmann@charlotte.med.nyu.edu] (Center Director), Richard B. Schlesinger (Co-Center Director), Beverly S. Cohen, Terry Gordon, Joan Reibman, George D. Thurston, Lung Chi Chen, Kazuhiko K. Ito, Christine C. Nadziejko, Judith T. Zelikoff,M	Gail Robarge	\$8,076,438	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
43	R823990	<a href="#">Organic Tracers of Plant Classes in Biomass Combustion and Smoke in Aerosols</a>	Oregon State University	Bernd R.T. Simoneit	Paul Shapiro	\$196,244	October 1, 1995 - September 30, 1997	<a href="#">Highlighted</a>
44	R824792	<a href="#">Quantification of Uncertainty in Air Quality Models Used for Analysis of Ozone Control Strategies</a>	University of Colorado; University of California	Jana B. Milford and Robert A. Harley	Deran Pashayan	\$426,233	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>

	45	R827027	<a href="#">Research on Asthma</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	46	R823186	<a href="#">Project to Further Research, Develop, and Apply a New Air Pollution Modeling System</a>	Stanford University	Mark Z. Jacobson	Paul Shapiro	\$325,701	September 1, 1995 - August 31, 1998	<a href="#">Highlighted</a>
	47	R826770	<a href="#">Development of Techniques for Assimilating GOES Satellite Data into Regional-Scale Photochemical Models</a>	University of Alabama in Huntsville	R. T. McNider, W. B. Norris, and S. A. Christopher	Paul Shapiro	\$404,127	July 1, 1998 - June 30, 2001	<a href="#">Highlighted</a>
	48	R828577	<a href="#">Rapid Mapping for Clean Air in Commerce City</a>	Tri-County Health Department, Commerce City, CO; University of Colorado Health Sciences Center, Denver, CO; University of Colorado, Boulder, CO; Metropolitan State College, Denver, CO	John W. Martyny, Ph.D., A. James Ruttenber, M.D., Jana B. Milford, Ph.D., Raphael Moreno, Ph.D.	Madalene Stevens	\$400,000	January 1, 2001 - December 31, 2002	<a href="#">Highlighted</a>
	49	R826724	<a href="#">Mechanisms Of Particulate-Induced Allergic Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Marsha Wills-Karp, Ph.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>

	50	R826779	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	Harvard University	Lester Kobzik, Petros Koutrakis, Stephanie Shore, Beatriz Gonzalez-Flecha	Deran Pashayan	\$557,340	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	51	R826270	<a href="#">Mechanisms of Particulate-Induced Mediator Expression in Human Airway Epithelial Cells</a>	University of North Carolina at Chapel Hill	William Reed, Lee M. Graves	Deran Pashayan	\$374,170	December 15, 1997 - December 14, 2000	<a href="#">Highlighted</a>
	52	none	<a href="#">Process Impacts On Trace Element Speciation</a>	University of North Dakota - EERC	Christopher J. Zygarlicke, Grant L. Schelkoph, Stanley J. Miller, Kevin C. Galbreath, Michael D. Mann	none	\$540,000	9/30/98 ending date	<a href="#">Highlighted</a>
	53	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	54	R829214	<a href="#">Mechanisms of Air Pollutant-induced Pulmonary Inflammation; Effects of Zinc on EGFR Receptor Function</a>	University of North Carolina, Chapel Hill, NC	Lee M. Graves (lmg@med.unc.edu), Weidong Wu	Gail Robarge/Stacey Katz	\$874,125	November 19, 2001 ù November 18, 2004	<a href="#">Highlighted</a>
	55	R826772	<a href="#">Improved Photolytic Rate Measurements at PAMS Sites</a>	Georgia Institute of Technology	Michael O. Rodgers and James R. Pearson	Paul Shapiro	\$168,930	March 22, 1999 - March 21, 2001	<a href="#">Highlighted</a>
	56	R827355C003	<a href="#">Personal PM Exposure Assessment</a>	University of Washington, Washington State University	L-J Sally Liu, Candis Claiborn, Lara Gundel, Timothy Larson	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	57	R827068	<a href="#">Burlington EMPACT Project</a>	City of Burlington, Vermont	Deane Wang, PhD (P.I.) and Tim Scherbatskoy, PhD, University of Vermont; Nick Warner, City of Burlington; Julie Silverman, Lake Champlain Science Center; Susan	Madalene Stevens	\$508,000	January 1, 1999 - December 31, 2000	<a href="#">Highlighted</a>

	58	R828170	<a href="#">Control of Mercury Emissions from Coal Combustion Sources</a>	University of Connecticut, University of Utah	Joseph J. Helble, Adel F. Sarofim,	Paul Shapiro	\$224,642	July 1, 2000 - June 30, 2002	<a href="#">Highlighted</a>
	59	R826238	<a href="#">Observation-Based Approaches to VOC Emissions Inventory Reconciliation And Control Strategies for Photochemical Smog</a>	University of Southern California	Ronald C. Henry	Paul Shapiro	\$441,574	February 1, 1998 - January 31, 2001	<a href="#">Highlighted</a>
	60	R825243	<a href="#">Anthropogenic Pollutant Effects on Aquatic Ecosystems Impacts of Atmospheric Nitrogen Deposition on Phytoplankton Dynamics and Eutrophication</a>	University of North Carolina at Chapel Hill; Southern Regional Research Center, US Department of Agriculture, Agricultural Research Service; Mote Marine Laboratory; Rutgers University	Hans Paerl and James L. Pinckney, David F. Millie, Gary J. Kirkpatrick, Oscar M.E. Schofield,	Deran Pashayan	\$382,789	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
	61	R828171	<a href="#">Development of a Membrane-Based Electrostatic Precipitator</a>	Ohio University	Hajrudin Pasic, Khairul Alam, David Bayless, and David Ingram	Paul Shapiro	\$225,000	August 1, 2000 - July 31, 2002	<a href="#">Highlighted</a>
	62	R827998	<a href="#">Health Effects of long-Term Exposure to Particles and Other Air Pollutants in Elderly Nonsmoking California Residents</a>	Loma Linda University	Synnove F. Knutsen, David E Abbey and Larry Beeson	Deran Pashayan	\$763,910	March 1, 2000 -- February 28, 2003	<a href="#">Highlighted</a>

	63	R824096	<a href="#">Human Influence on Ozone in the Tropical Troposphere: An Interpretation of Observations Using a Global Three-dimensional Model</a>	Harvard University	Daniel J. Jacob, Jennifer A. Logan, Clarisa M. Spivakovsky, and Steven C. Wofsy	Paul Shapiro	\$415,798	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
	64	R826244	<a href="#">Mechanism of PM-Induced Acute Health Effects</a>	New York University Medical Center	Terry Gordon	Deran Pashayan	\$600,799	January 23, 1998 - January 22, 2,001	<a href="#">Highlighted</a>
	65	R825391	<a href="#">Real-Time Analysis of PAH Bound to Size-Resolved Atmospheric Particles by Tandem Time of Flight Mass Spectrometers</a>	Massachusetts Institute of Technology	Kenneth Smith	Paul Shapiro	\$375,000	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
	66	R828731	<a href="#">Implications of Climate Change for Regional Air Pollution, Health Effects and Energy Consumption Behavior</a>	The Johns Hopkins University, Baltimore, MD; George Washington University, Washington, DC	J.H. Ellis (PI-JHU) [hugh.ellis@jhu.edu], B.F. Hobbs (JHU), J.F. Patz (JHU), J. Samet (JHU), M. Schwab (JHU), F. Joutz (GW)	Bernice Smith	\$1,376,739	September 1, 2000 - August 31, 2003	<a href="#">Highlighted</a>
	67	R823979	<a href="#">Effects of Non-Uniform Cloud Drop Composition on Pollutant Transformation and Removal in Winter Clouds</a>	Colorado State University	Jeffrey L. Collett, Jr.	Paul Shapiro	\$339,597	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>

	68	R826245	<a href="#">The Relative Associations of Transition Metals and Sources of Fine Particulate Matter to Increased Daily Mortality</a>	Harvard University, School of Public Health	Joel Schwartz	Deran Pashayan	\$ 211,733	January 14, 1998 - January 13, 2,000	<a href="#">Highlighted</a>
	69	R827719	<a href="#">Ferric Oxide/Alkali Metal Oxide Induced Oxidation of CHCs in Polluted Gas Streams</a>	LSU	Barry Dellinger, Ph.D.	Paul Shapiro	none	September 1, 1999 - August 31, 2002	<a href="#">Highlighted</a>
	70	R826246	<a href="#">Particle Toxicity and the Respiratory Bronchiole</a>	University of California	Kent E. Pinkerton, Alan Buckpitt, Charles Plopper	Deran Pashayan	\$525,000	February 1, 1998 - January 31, 2001	<a href="#">Highlighted</a>
	71	R827964	<a href="#">Paso del Norte Environmental Monitor</a>	City of El Paso, University of Texas at El Paso, Instituto Municipal de Investigaci³n y Planeaci³n	Charles Kooshian, Robert Gray, P.E., Salvador Gonzalez-Ayala	Madalene Stevens	\$494,935	January 2000 to December 2001	<a href="#">Highlighted</a>
	72	R826177	<a href="#">Environmental Applications of Novel Instrumentation for Measurement of Lead Isotope Ratios In Atmospheric Pollution Source Apportionment Studies</a>	University of Michigan, State University of New York at Binghamton	Gerald J. Keeler, Joseph R. Graney and Alexander N. Halliday	Paul Shapiro	\$99,776	December 1, 1997 - November 30, 1998	<a href="#">Highlighted</a>
	73	R826786	<a href="#">Characterization of Factors Determining Personal Exposure to Volatile Air Toxics in Urban Environments</a>	University of Oklahoma Health Sciences Center	N.A. Esmen, T.A. Hall, D.L. Johnson, and M.L. Phillips	Deran Pashayan	\$559,352	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>

	74	R826778	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	Lovelace Biomedical and Environmental Research Institute (NM)	Janet M. Benson (PI), Edward B. Barr, David E. Bice, Yung-Sung Cheng, Joe L. Mauderly	Deran Pashayan	\$199,035	October 1, 1977 - September 30, 1999	<a href="#">Highlighted</a>
	75	R827353C005	<a href="#">Assessing Life-Shortening Associated with Exposure to Particulate Matter</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
	76	R826783	<a href="#">Relationship of Ambient Particulate Matter to Heart Rate Variability and Cardiac Arrhythmias in Elderly Adults with Coronary Artery Disease</a>	California Office of Environmental Health Hazard Assessment (1), University of California (UC), San Francisco (2), UC Berkeley (3), UC Los Angeles (4), Eisenhower Medical Center, Rancho Mirage, CA (5)	Bart Ostro (1), Michael Lipsett (1), (2), Ira Tager (3), Mary Woo (4), Merle Bolton (5)	Deran Pashayan	\$436,964	October 1, 1998 September 30, 2000	<a href="#">Highlighted</a>
	77	R828046	<a href="#">Pulmonary and Systemic Effects of Inhaled Ultrafine Particles in Senescent Rats with Cardiovascular Disease</a>	University of Rochester	Alison C.P. Elder, Jean-Philippe Couderc, Mark Frampton, G3nter Oberdörster, Wojciech Zareba	Deran Pashayan	\$408,859	March 24, 2000 - March 23,2003	<a href="#">Highlighted</a>

	78	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	79	R826790	<a href="#">Probabilistic Modeling of Variability and Uncertainty in Urban Air Toxics Emissions</a>	North Carolina State University	H. Christopher Frey	Deran Pashayan	\$329,425	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
	80	R827353	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	Harvard University	Petros Koutrakis [petros@hsph.harvard.edu] (Center Director), John J. Godleski, (Center Co-Director), Joel Schwartz, (Center Co-Director), Douglas W. Dockery, Frank E. Speizer, Helen H. Suh, Diane R. Gold, Richard L. Verrier, James Ware, Paul Catalano, Jo	Stacey Katz	\$7,747,040	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	81	none	<a href="#">Experimental and Modeling Studies of Chlorocarbon Incineration, PIC Formation, and Emissions Control</a>	New Jersey Institute of Technology	Robert B. Barat and Joseph Bozzelli	none	none	none	<a href="#">Highlighted</a>
	82	R829216	<a href="#">Effects of Airborne Particles on Allergic Airway Disease</a>	(1)Michigan State University, East Lansing, MI; (2)University of Southern California and the Southern California Particle Center and Supersite, Los Angeles, CA	Jack Harkema, DVM, Ph.D., (PI) [harkemaj@msu.edu](1); Constantinos Sioutas, Ph.D. (Co-PI)(2)	Gail Robarge/Stacey Katz	\$854,702	October 31, 2001 û October 30, 2004	<a href="#">Highlighted</a>

83	R826371	<a href="#">Research Consortium on Ozone and Fine Particle Formation in California and in the Northeastern United States</a>	California Institute of Technology, University of California at Riverside, New Jersey Institute of Technology, University of California at Irvine, Carnegie-Mellon University, Oregon Graduate Institute of Science and Technology, Georgia Institute of Technology	Glen Cass, Richard Flagan and John Seinfeld; Janet Arey, Roger Atkinson, and Kimberly Prather; Joseph Bozzelli; Donald Dabdub; Cliff Davidson and Spyros Pandis; James Pankow; Armistead Russell	Paul Shapiro	\$3,000,000	April 15, 1998 - April 14, 2001	<a href="#">Highlighted</a>
84	R826372	<a href="#">Southern Center For the Integrated Study of Secondary Air Pollutants (SCISSAP)</a>	Georgia Institute of Technology	William L. Chameides	Paul Shapiro	\$3,000,000	April 1, 1998 - March 31, 2001	<a href="#">Highlighted</a>
85	R824970	<a href="#">Experimental Investigation of the Evolution of the Size and Composition Distribution of Atmospheric Organic Aerosols</a>	California Institute of Technology	Glen Cass	Paul Shapiro	\$75,000.00	05/31/98 ending date	<a href="#">Highlighted</a>
86	none	<a href="#">Investigation of the Formation of Particulate Matter in Spark-Ignited Engines</a>	Massachusetts Institute of Technology	Simone Hochgreb and Arthur Lafleur	none	\$75,000.00	06/30/99 ending date	<a href="#">Highlighted</a>
87	none	<a href="#">Aerosols and Global Climate Change: Improving the EPAÆs Modeling Efforts</a>	none	Laurie S. Geller	none	none	none	<a href="#">Highlighted</a>

88	R827354	<a href="#">Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</a>	University of Rochester; California Institute of Technology; University of California at Riverside; GSF - National Research Center for Environment & Health (Neuherberg, Germany); Research Triangle Institute; State University of New York at Buffalo; Univer	Gunter Oberdorster (Center Director), Mark Utell (Co-Center Director), William Beckett, Christopher Cox, Jacob Finkelstein, Mark Frampton, John Looney, Victor Marder, P. E. Morrow, Michael O'Reilly, Richard Phipps, Edward Schwarz, Barry Stripp and Wojciec	Gail Robarge	\$8,302,447	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
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## Tabular Query Results of NCER Program and Solicitation Information

70 Abstracts are listed

Your Query was:

((particulate matter <or> pm) <and> (ambient air <or>air) <and> (monitor\* <or> measure\*))

*Narrow your search results by entering additional terms:*

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R825267	<a href="#">Development of Population-Based Particle Exposure Models for Human Health Risk Assessment</a>	Harvard University	John D. Spengler	Deran Pashayan	\$500,065	December 2, 1996 - December 1, 1999	<a href="#">Highlighted</a>

2	R822351	<a href="#">2 to 5 pm Room-Temperature Semiconductor Multiquantum Well Tunable Photodetectors for Ultrasensitive Detection of Hazardous Pollutants</a>	Rutgers, The State University of New Jersey	Jian Zhao	none	none	3 years	<a href="#">Highlighted</a>
3	R827999	<a href="#">Acute Cardiopulmonary Responses to Fine Particulate Pollution and Copollutant Oxidant Gase in Los Angeles</a>	Rancho Los Amigos National Rehabilitation Center; University of Southern California	Henry Gong, Jr.; Constantinos Sioutas	Deran Pashayan	\$613,894	03/15/2000 to 03/14/2003	<a href="#">Highlighted</a>
4	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30. 2001	<a href="#">Highlighted</a>
5	none	<a href="#">Estimation of Indoor Particulate Matter Emissions in Large Office Buildings: A Preliminary Evaluation of EPAÆs BASE Study Data</a>	none	Adam C. Johnston	none	none	none	<a href="#">Highlighted</a>
6	R827353C005	<a href="#">Assessing Life-Shortening Associated with Exposure to Particulate Matter</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>

7	R823980	<a href="#">Speciation of Volatile and Reacting Compounds in Particulate Matter</a>	University of Delaware	Murray V. Johnston and Anthony S. Wexler	Paul Shapiro	\$334,455	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
8	R826768	<a href="#">Modeling and Evaluation of Mechanisms Controlling the Outdoor/Indoor Relationships of Fine Particle Levels and Characteristics</a>	University of Medicine and Dentistry of New Jersey	Panos G. Georgopoulos	Paul Shapiro	\$170,828	October 1, 1998 - September 30, 2000	<a href="#">Highlighted</a>
9	R827355C002	<a href="#">Health Effects of PM in Susceptible Populations</a>	University of Washington	Jane Q. Koenig, Joel Kaufman, Carol Trenga, Jeff Sullivan, Sally Liu, Tim Larson, Lianne Sheppard, Thomas Lumley, Karen Jansen	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
10	R827355	<a href="#">Northwest Research Center for Particulate Air Pollution and Health University of Washington</a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
11	R827353C001	<a href="#">Assessing Human Exposures to Particulate and Gaseous Air Pollutants</a>	Harvard University	Petros Koutrakis	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
12	R827355C003	<a href="#">Personal PM Exposure Assessment</a>	University of Washington, Washington State University	L-J Sally Liu, Candis Claiborn, Lara Gundel, Timothy Larson	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
13	68D50095	<a href="#">Instrument for Monitoring Fine, Respirable Particulate Matter in Flue Gases</a>	Advanced Fuel Research, Inc.	Mr. James R. Markham	none	\$64,836	September 1995 - March 1996	<a href="#">Highlighted</a>

14	R825264	<a href="#">Acidic PM and Daily Human Mortality in Three U.S. Cities</a>	New York University Medical Center	George D. Thurston	Deran Pashayan	\$383,008	November 18, 1996 - November 17, 1999	<a href="#">Highlighted</a>
15	R81-9732	<a href="#">Dry Deposition of Atmospheric Particles: Application of Current Models to Ambient Data</a>	Illinois Institute of Technology	Thomas M. Holsen	none	none	2 years	<a href="#">Highlighted</a>
16	R827997	<a href="#">A Source-Oriented Evaluation of the Combined Effects of Fine Particles and Copollutants</a>	Nelson Institute of Environ. Medicine, New York University School of Medicine	Kazuhiko Ito and George D. Thurston	Deran Pashayan	\$478,522	02/18/2000 to 02/17/2004	<a href="#">Highlighted</a>
17	68D01008	<a href="#">Optical Monitor for Noninvasive, Chemical- and Size-Differentiated Characterization of Airborne Aerosols</a>	Air Instruments & Measurements, Inc.	Harry C. Lord III	none	\$69,783	April 2001 - September 2001	<a href="#">Highlighted</a>
18	R827352	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	University of California at Los Angeles; California Institute of Technology; Rancho Los Amigos Medical Center; University of California at Irvine; University of California at Riveside; University of Southern California	John R. Froines [jfroines@ucla.edu] (Center Director), Steven D. Colome (Co-Center Director) and Richard P. Turco (Co-Center Director), Arthur K. Cho, Yoram Cohen, Annmarie Eldering, Sheldon K. Friedlander, Stella C. Grosser, Oliver Hankinson, William C.	Stacey Katz	\$8,715,583	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

19	R829213	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#">Highlighted</a>
20	R827994	<a href="#">Cardiovascular Responses to Particulate Air Pollution</a>	Pennsylvania State University; University of North Carolina at Chapel Hill	Duanping Liao, Vernon M. Chinchilli; Gerardo Heiss, Carl Shy	Deran Pashayan	\$607,630	January 2000 - January 2003	<a href="#">Highlighted</a>
21	R827996	<a href="#">Inhalability of Particulate Matter in Laboratory Animals</a>	Chemical Industry Institute of Toxicology	Bahman Asgharian	Deran Pashayan	\$335,903	01/17/2000 to 01/16/2002	<a href="#">Highlighted</a>
22	R826783	<a href="#">Relationship of Ambient Particulate Matter to Heart Rate Variability and Cardiac Arrhythmias in Elderly Adults with Coronary Artery Disease</a>	California Office of Environmental Health Hazard Assessment (1), University of California (UC), San Francisco (2), UC Berkeley (3), UC Los Angeles (4), Eisenhower Medical Center, Rancho Mirage, CA (5)	Bart Ostro (1), Michael Lipsett (1), (2), Ira Tager (3), Mary Woo (4), Merle Bolton (5)	Deran Pashayan	\$436,964	October 1, 1998 September 30, 2000	<a href="#">Highlighted</a>
23	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

24	68D99070	<a href="#">Development of a Real-Time In Situ Organic/Elemental Carbon (OC/EC) Analyzer</a>	Sunset Laboratory, Inc.	Mr. R.A. Cary	none	\$69,644	September 1999 - March 2000	<a href="#">Highlighted</a>
25	R824796	<a href="#">A Study of Ozone Concentration Gradients in Large Buildings, Including an Examination of Indoor Chemistry, Ventilation, Occupant Health Effects and Effects on HVAC Systems</a>	Harvard University School of Public Health	John D. Spengler	Deran Pashayan	\$425,708	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
26	R828686	<a href="#">Spatial and Temporal Models for Environmental Health Effects</a>	Duke University, Durham, NC	Merlise Clyde (clyde@stat.duke.edu)	Chris Saint	\$557,859	February 12, 2001 - February 11, 2004	<a href="#">Highlighted</a>
27	R826780	<a href="#">Cardiovascular Vulnerability to Particulate Pollution</a>	Harvard School of Public Health	Diane R. Gold, Peter Stone, Augusto Litonjua; Richard Verrier, Joel Schwartz	Deran Pashayan	\$648,227	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
28	R829214	<a href="#">Mechanisms of Air Pollutant-induced Pulmonary Inflammation; Effects of Zinc on EGFR Receptor Function</a>	University of North Carolina, Chapel Hill, NC	Lee M. Graves (lmg@med.unc.edu), Weidong Wu	Gail Robarge/Stacey Katz	\$874,125	November 19, 2001 û November 18, 2004	<a href="#">Highlighted</a>
29	R827355C004	<a href="#">Dosimetry Assessment: Aerosol Number, Size Distribution, and Dosimetry Measurements and Modeling</a>	University of Washington	David S. Covert, Timothy Larson, Eugene Kim, Rob Elleman	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

30	R827353C010	<a href="#">Relating Changes in Blood Viscosity, Other Clotting Parameters, Heart Rate, and Heart Rate Variability to Particulate and Criteria Gas Exposures</a>	Harvard University	Frank Speizer	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
31	R826244	<a href="#">Mechanism of PM-Induced Acute Health Effects</a>	New York University Medical Center	Terry Gordon	Deran Pashayan	\$600,799	January 23, 1998 - January 22, 2001	<a href="#">Highlighted</a>
32	none	<a href="#">Investigation of the Formation of Particulate Matter in Spark-Ignited Engines</a>	Massachusetts Institute of Technology	Simone Hochgreb and Arthur Lafleur	none	\$75,000.00	06/30/99 ending date	<a href="#">Highlighted</a>
33	R826654	<a href="#">Development of a Novel Condensation Nuclei Counter and Application to Ultrafine Particle Formation</a>	Clarkson University1, Illinois Institute of Technology2	Philip K. Hopke1, Hwa-Chi Wang2	Paul Shapiro	\$393,657	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
34	R826246	<a href="#">Particle Toxicity and the Respiratory Bronchiole</a>	University of California	Kent E. Pinkerton, Alan Buckpitt, Charles Plopper	Deran Pashayan	\$525,000	February 1, 1998 - January 31, 2001	<a href="#">Highlighted</a>
35	R827351	<a href="#">Health Risks of PM Components</a>	New York University School of Medicine; University of Iowa	Morton Lippmann [lippmann@charlotte.med.nyu.edu] (Center Director), Richard B. Schlesinger (Co-Center Director), Beverly S. Cohen, Terry Gordon, Joan Reibman, George D. Thurston, Lung Chi Chen, Kazuhiko K. Ito, Christine C. Nadziejko, Judith T. Zelikoff,M	Gail Robarge	\$8,076,438	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

36	68D60057	<a href="#">Method for Direct Continuous Monitoring of Particulate Emissions from Industrial Effluents</a>	LSR Technologies, Inc.	Dr. ZhenWu Lin	none	\$225,000	September 1996 - September 1998	<a href="#">Highlighted</a>
37	R827353C006	<a href="#">Investigating Chronic Effects of Exposure to Particulate Matter</a>	Harvard University	Douglas Dockery	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
38	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	Harvard University	John Godleski	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
39	R826773	<a href="#">A Modeling Investigation of NHx Cycling in the Troposphere and Its Impact on Particulate Matter and Acidic Substances Budgets</a>	MCNC-North Carolina Supercomputing Center	Rohit Mathur, Uma Shankar, Carlie J. Coats, John McHenry, and Marc Houyoux	Paul Shapiro	\$488,744	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
40	68D50089	<a href="#">Method for Direct Continuous Monitoring of Particulate Emissions from Industrial Effluents</a>	LSR Technologies, Inc.	Dr. ZhenWu Lin	none	\$65,000	September 1995 - March 1996	<a href="#">Highlighted</a>
41	R827353C002	<a href="#">Quantifying Exposure Error and its Effect on Epidemiological Studies</a>	Harvard University	Helen Suh	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
42	R826782	<a href="#">Airborne Particulate Matter-Induced Lung Inflammation</a>	University of Texas Houston Health Science Center	Andrij Holian, Maria T. Morandi, Edwin Parsley	Deran Pashayan	\$674,288	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>

43	R825271	<a href="#">An Evaluation of Confounders in PM10/Mortality Associations</a>	New York University Medical Center	Kazuhiko Ito	Deran Pashayan	\$363,394	November 25, 1996 - November, 24, 1999	<a href="#">Highlighted</a>
44	R827027	<a href="#">Research on Asthma</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
45	R826770	<a href="#">Development of Techniques for Assimilating GOES Satellite Data into Regional-Scale Photochemical Models</a>	University of Alabama in Huntsville	R. T. McNider, W. B. Norris, and S. A. Christopher	Paul Shapiro	\$404,127	July 1, 1998 - June 30, 2001	<a href="#">Highlighted</a>
46	GF-95-01349	<a href="#">Experimental Studies of the Factors Controlling the Water Nucleating Ability of Atmospheric Particulate Matter</a>	Colorado State University	Fredrick J. Brechtel	Virginia Broadway	\$25,446	9/1/95	<a href="#">Highlighted</a>
47	R827353C003	<a href="#">Differentiating Health Effects of Particles from Outdoor and Indoor Sources</a>	Harvard University	Diane Gold, Peter Stone	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
48	R824791	<a href="#">Distribution of H+ and Trace Metals in Ultrafine Ambient Aerosol</a>	New York University Medical Center	Beverly S. Cohen	Deran Pashayan	\$589,560	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>

49	R829215	<a href="#">Health Effects of Airborne Particulate Matter and Gasses</a>	University of California, Davis, Davis, CA (1); University of Utah, Salt Lake City, UT (2); and Utah State University, Logan, UT (3)	(3)	Stacey Katz/Gail Robarge	\$833,481	October 1, 2001 - September 30, 2004	<a href="#">Highlighted</a>
50	R826779	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	Harvard University	Lester Kobzik, Petros Koutrakis, Stephanie Shore, Beatriz Gonzalez-Flecha	Deran Pashayan	\$557,340	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
51	R826772	<a href="#">Improved Photolytic Rate Measurements at PAMS Sites</a>	Georgia Institute of Technology	Michael O. Rodgers and James R. Pearson	Paul Shapiro	\$168,930	March 22, 1999 - March 21, 2001	<a href="#">Highlighted</a>
52	R828170	<a href="#">Control of Mercury Emissions from Coal Combustion Sources</a>	University of Connecticut, University of Utah	Joseph J. Helble, Adel F. Sarofim,	Paul Shapiro	\$224,642	July 1, 2000 - June 30, 2002	<a href="#">Highlighted</a>
53	R826234	<a href="#">Real-time Measurement of the Size and Composition of Atmospheric Particulate Matter</a>	University of Delaware	Anthony S. Wexler	Paul Shapiro	\$374,833	December 15, 1997 - December 14, 2000	<a href="#">Highlighted</a>
54	R828172	<a href="#">Eddy-Correlation Measurement of Size-Segregated and Composition-Resolved Aerosol Depositional Flux Using an Aerosol Mass Spectrometer</a>	Massachusetts Institute of Technology	Kenneth A. Smith	Paul Shapiro	\$225,000	July 24, 2000 - July 23, 2002	<a href="#">Highlighted</a>
55	R823514	<a href="#">Formation and Physical Properties of Secondary Organic Aerosol</a>	Carnegie Mellon University	Spyros N. Pandis	Paul Shapiro	\$382,668	September 28, 1995 - September 27, 1998	<a href="#">Highlighted</a>

56	R826781	<a href="#">Human Health Effects of Exposure to Ultrafine Particles</a>	University of Rochester School of Medicine and Dentistry	Mark W. Frampton, Mark J. Utell, Gunter Oberdorster, Victor Marder, Wojciech Zareba	Deran Pashayan	\$736,260	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
57	R826609	<a href="#">The Role of Locational Equilibria and Collective Behavior in Measuring the Benefits of Air Pollution Policies</a>	Duke University	V. Kerry Smith and Holger Sieg	Matthew Clark	\$199,948	September 1, 1998 - August 31, 2001	<a href="#">Highlighted</a>
58	R827353	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	Harvard University	Petros Koutrakis [petros@hsph.harvard.edu] (Center Director), John J. Godleski, (Center Co-Director), Joel Schwartz, (Center Co-Director), Douglas W. Dockery, Frank E. Speizer, Helen H. Suh, Diane R. Gold, Richard L. Verrier, James Ware, Paul Catalano, Jo	Stacey Katz	\$7,747,040	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
59	R826767	<a href="#">Aerosol Partitioning and Heterogeneous Chemistry</a>	The University of North Carolina at Chapel Hill	Roger E. Miller and Cindy DeForest Hauser	Paul Shapiro	\$338,749	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
60	R825305	<a href="#">Development of a Continuous Monitoring System for PM10 and Components of PM2.5</a>	New York University Medical Center	Morton Lippmann	Bill Stelz	\$436,262	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
61	R826786	<a href="#">Characterization of Factors Determining Personal Exposure to Volatile Air Toxics in Urban Environments</a>	University of Oklahoma Health Sciences Center	N.A. Esmen, T.A. Hall, D.L. Johnson, and M.L. Phillips	Deran Pashayan	\$559,352	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>

62	R826778	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	Lovelace Biomedical and Environmental Research Institute (NM)	Janet M. Benson (PI), Edward B. Barr, David E. Bice, Yung-Sung Cheng, Joe L. Mauderly	Deran Pashayan	\$199,035	October 1, 1977 - September 30, 1999	<a href="#">Highlighted</a>
63	R827058	<a href="#">Time-Relevant Communication of Ozone and Particulate Air Pollution Data: A Pilot Project to Raise Public Awareness and Promote Exposure Reduction</a>	Suffolk County Conservation District, Massachusetts	Matthew Goode, Suffolk County Conservation District; Lee Alter, Northeast States for Coordinated Air Use Management; Petros Koutrakis, Harvard School of Public Health; Penn Loh, Alternatives for Community & Environment; Nancy Seidman, Massachusetts De	Madalene Stevens	\$527,000	November 1, 1998 - October 31, 2000	<a href="#">Highlighted</a>
64	R826769	<a href="#">A Portable Device for Real-Time Measurement of the Size and Composition of Atmospheric Aerosols</a>	University of Delaware1; New Mexico State University2	Murray V. Johnston1 and Gary A. Eiceman2	Paul Shapiro	\$580,963	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
65	R827995	<a href="#">Health Effects of Concentrated Ambient Particles from the Central Valley of California</a>	University of California, Davis; University of Southern California	Kent E. Pinkerton; Constantinos Sioutas	Deran Pashayan	\$633,328	02/01/2000 to 01/31/2003	<a href="#">Highlighted</a>
66	none	<a href="#">Experimental and Modeling Studies of Chlorocarbon Incineration, PIC Formation, and Emissions Control</a>	New Jersey Institute of Technology	Robert B. Barat and Joseph Bozzelli	none	none	none	<a href="#">Highlighted</a>

67	none	<a href="#">China - Innovative Waste Composting Plan for the City of Benxi, People's Republic of China</a>	Urban Waste Management & Research Center	John N. Crisp, Ph.D., P.E., Professor, College of Engineering	none	none	none	<a href="#">Highlighted</a>
68	R827993	<a href="#">Relationship Between PM2.5 Semi-volatile Organic Material, Other PM2.5 Components and Heart Rate Variability in The Elderly</a>	Brigham Young University	Delbert J. Eatough, C. Arden Pope III	Deran Pashayan	\$797,013	02/01/2000 to 01/31/2003	<a href="#">Highlighted</a>
69	R824970	<a href="#">Experimental Investigation of the Evolution of the Size and Composition Distribution of Atmospheric Organic Aerosols</a>	California Institute of Technology	Glen Cass	Paul Shapiro	\$75,000.00	05/31/98 ending date	<a href="#">Highlighted</a>
70	R827354	<a href="#">Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</a>	University of Rochester; California Institute of Technology; University of California at Riverside; GSF - National Research Center for Environment & Health (Neuherberg, Germany); Research Triangle Institute; State University of New York at	Gunter Oberdorster (Center Director), Mark Utell (Co-Center Director), William Beckett, Christopher Cox, Jacob Finkelstein, Mark Frampton, John Looney, Victor Marder, P. E. Morrow, Michael O'Reilly, Richard Phipps, Edward Schwarz, Barry Stripp and Wojciec	Gail Robarge	\$8,302,447	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

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## Tabular Query Results of NCER Program and Solicitation Information

**70 Abstracts are listed**

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Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R825267	<a href="#">Development of Population-Based Particle Exposure Models for Human Health Risk Assessment</a>	Harvard University	John D. Spengler	Deran Pashayan	\$500,065	December 2, 1996 - December 1, 1999	<a href="#">Highlighted</a>

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2	R822351	<a href="#">2 to 5 pm Room-Temperature Semiconductor Multiquantum Well Tunable Photodetectors for Ultrasensitive Detection of Hazardous Pollutants</a>	Rutgers, The State University of New Jersey	Jian Zhao	none	none	3 years	<a href="#">Highlighted</a>
3	R827999	<a href="#">Acute Cardiopulmonary Responses to Fine Particulate Pollution and Copollutant Oxidant Gase in Los Angeles</a>	Rancho Los Amigos National Rehabilitation Center; University of Southern California	Henry Gong, Jr.; Constantinos Sioutas	Deran Pashayan	\$613,894	03/15/2000 to 03/14/2003	<a href="#">Highlighted</a>
4	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30. 2001	<a href="#">Highlighted</a>
5	none	<a href="#">Estimation of Indoor Particulate Matter Emissions in Large Office Buildings: A Preliminary Evaluation of EPAÆs BASE Study Data</a>	none	Adam C. Johnston	none	none	none	<a href="#">Highlighted</a>
6	R827353C005	<a href="#">Assessing Life-Shortening Associated with Exposure to Particulate Matter</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
7	R823980	<a href="#">Speciation of Volatile and Reacting Compounds in Particulate Matter</a>	University of Delaware	Murray V. Johnston and Anthony S. Wexler	Paul Shapiro	\$334,455	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>

8	R826768	<a href="#">Modeling and Evaluation of Mechanisms Controlling the Outdoor/Indoor Relationships of Fine Particle Levels and Characteristics</a>	University of Medicine and Dentistry of New Jersey	Panos G. Georgopoulos	Paul Shapiro	\$170,828	October 1, 1998 - September 30, 2000	<a href="#">Highlighted</a>
9	R827355C002	<a href="#">Health Effects of PM in Susceptible Populations</a>	University of Washington	Jane Q. Koenig, Joel Kaufman, Carol Trenga, Jeff Sullivan, Sally Liu, Tim Larson, Lianne Sheppard, Thomas Lumley, Karen Jansen	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
10	R827355	<a href="#">Northwest Research Center for Particulate Air Pollution and Health University of Washington</a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
11	R827353C001	<a href="#">Assessing Human Exposures to Particulate and Gaseous Air Pollutants</a>	Harvard University	Petros Koutrakis	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
12	R827355C003	<a href="#">Personal PM Exposure Assessment</a>	University of Washington, Washington State University	L-J Sally Liu, Candis Claiborn, Lara Gundel, Timothy Larson	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
13	68D50095	<a href="#">Instrument for Monitoring Fine, Respirable Particulate Matter in Flue Gases</a>	Advanced Fuel Research, Inc.	Mr. James R. Markham	none	\$64,836	September 1995 - March 1996	<a href="#">Highlighted</a>
14	R825264	<a href="#">Acidic PM and Daily Human Mortality in Three U.S. Cities</a>	New York University Medical Center	George D. Thurston	Deran Pashayan	\$383,008	November 18, 1996 - November 17, 1999	<a href="#">Highlighted</a>
15	R81-9732	<a href="#">Dry Deposition of Atmospheric Particles: Application of Current Models to Ambient Data</a>	Illinois Institute of Technology	Thomas M. Holsen	none	none	2 years	<a href="#">Highlighted</a>

16	R827997	<a href="#">A Source-Oriented Evaluation of the Combined Effects of Fine Particles and Copollutants</a>	Nelson Institute of Environ. Medicine, New York University School of Medicine	Kazuhiko Ito and George D. Thurston	Deran Pashayan	\$478,522	02/18/2000 to 02/17/2004	<a href="#">Highlighted</a>
17	68D01008	<a href="#">Optical Monitor for Noninvasive, Chemical- and Size-Differentiated Characterization of Airborne Aerosols</a>	Air Instruments & Measurements, Inc.	Harry C. Lord III	none	\$69,783	April 2001 - September 2001	<a href="#">Highlighted</a>
18	R827352	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	University of California at Los Angeles; California Institute of Technology; Rancho Los Amigos Medical Center; University of California at Irvine; University of California at Riverside; University of Southern California	John R. Froines [jfroines@ucla.edu] (Center Director), Steven D. Colome (Co-Center Director) and Richard P. Turco (Co-Center Director), Arthur K. Cho, Yoram Cohen, Annmarie Eldering, Sheldon K. Friedlander, Stella C. Grosser, Oliver Hankinson, William C.	Stacey Katz	\$8,715,583	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
19	R829213	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#">Highlighted</a>
20	R827994	<a href="#">Cardiovascular Responses to Particulate Air Pollution</a>	Pennsylvania State University; University of North Carolina at Chapel Hill	Duanping Liao, Vernon M. Chinchilli; Gerardo Heiss, Carl Shy	Deran Pashayan	\$607,630	January 2000 - January 2003	<a href="#">Highlighted</a>

21	R827996	<a href="#">Inhalability of Particulate Matter in Laboratory Animals</a>	Chemical Industry Institute of Toxicology	Bahman Asgharian	Deran Pashayan	\$335,903	01/17/2000 to 01/16/2002	<a href="#">Highlighted</a>
22	R826783	<a href="#">Relationship of Ambient Particulate Matter to Heart Rate Variability and Cardiac Arrhythmias in Elderly Adults with Coronary Artery Disease</a>	California Office of Environmental Health Hazard Assessment (1), University of California (UC), San Francisco (2), UC Berkeley (3), UC Los Angeles (4), Eisenhower Medical Center, Rancho Mirage, CA (5)	Bart Ostro (1), Michael Lipsett (1), (2), Ira Tager (3), Mary Woo (4), Merle Bolton (5)	Deran Pashayan	\$436,964	October 1, 1998 September 30, 2000	<a href="#">Highlighted</a>
23	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
24	68D99070	<a href="#">Development of a Real-Time In Situ Organic/Elemental Carbon (OC/EC) Analyzer</a>	Sunset Laboratory, Inc.	Mr. R.A. Cary	none	\$69,644	September 1999 - March 2000	<a href="#">Highlighted</a>
25	R824796	<a href="#">A Study of Ozone Concentration Gradients in Large Buildings, Including an Examination of Indoor Chemistry, Ventilation, Occupant Health Effects and Effects on HVAC Systems</a>	Harvard University School of Public Health	John D. Spengler	Deran Pashayan	\$425,708	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
26	R828686	<a href="#">Spatial and Temporal Models for Environmental Health Effects</a>	Duke University, Durham, NC	Merlise Clyde (clyde@stat.duke.edu)	Chris Saint	\$557,859	February 12, 2001 - February 11, 2004	<a href="#">Highlighted</a>

27	R826780	<a href="#">Cardiovascular Vulnerability to Particulate Pollution</a>	Harvard School of Public Health	Diane R. Gold, Peter Stone, Augusto Litonjua; Richard Verrier, Joel Schwartz	Deran Pashayan	\$648,227	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
28	R829214	<a href="#">Mechanisms of Air Pollutant-induced Pulmonary Inflammation; Effects of Zinc on EGFR Receptor Function</a>	University of North Carolina, Chapel Hill, NC	Lee M. Graves (lmg@med.unc.edu), Weidong Wu	Gail Robarge/Stacey Katz	\$874,125	November 19, 2001 - November 18, 2004	<a href="#">Highlighted</a>
29	R827355C004	<a href="#">Dosimetry Assessment: Aerosol Number, Size Distribution, and Dosimetry Measurements and Modeling</a>	University of Washington	David S. Covert, Timothy Larson, Eugene Kim, Rob Elleman	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
30	R827353C010	<a href="#">Relating Changes in Blood Viscosity, Other Clotting Parameters, Heart Rate, and Heart Rate Variability to Particulate and Criteria Gas Exposures</a>	Harvard University	Frank Speizer	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
31	R826244	<a href="#">Mechanism of PM-Induced Acute Health Effects</a>	New York University Medical Center	Terry Gordon	Deran Pashayan	\$600,799	January 23, 1998 - January 22, 2001	<a href="#">Highlighted</a>
32	none	<a href="#">Investigation of the Formation of Particulate Matter in Spark-Ignited Engines</a>	Massachusetts Institute of Technology	Simone Hochgreb and Arthur Lafleur	none	\$75,000.00	06/30/99 ending date	<a href="#">Highlighted</a>
33	R826654	<a href="#">Development of a Novel Condensation Nuclei Counter and Application to Ultrafine Particle Formation</a>	Clarkson University1, Illinois Institute of Technology2	Philip K. Hopke1, Hwa-Chi Wang2	Paul Shapiro	\$393,657	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>

34	R826246	<a href="#">Particle Toxicity and the Respiratory Bronchiole</a>	University of California	Kent E. Pinkerton, Alan Buckpitt, Charles Plopper	Deran Pashayan	\$525,000	February 1, 1998 - January 31, 2001	<a href="#">Highlighted</a>
35	R827351	<a href="#">Health Risks of PM Components</a>	New York University School of Medicine; University of Iowa	Morton Lippmann [lippmann@charlotte.med.nyu.edu] (Center Director), Richard B. Schlesinger (Co-Center Director), Beverly S. Cohen, Terry Gordon, Joan Reibman, George D. Thurston, Lung Chi Chen, Kazuhiko K. Ito, Christine C. Nadziejko, Judith T. Zelikoff,M	Gail Robarge	\$8,076,438	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
36	68D60057	<a href="#">Method for Direct Continuous Monitoring of Particulate Emissions from Industrial Effluents</a>	LSR Technologies, Inc.	Dr. ZhenWu Lin	none	\$225,000	September 1996 - September 1998	<a href="#">Highlighted</a>
37	R827353C006	<a href="#">Investigating Chronic Effects of Exposure to Particulate Matter</a>	Harvard University	Douglas Dockery	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
38	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	Harvard University	John Godleski	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
39	R826773	<a href="#">A Modeling Investigation of NHx Cycling in the Troposphere and Its Impact on Particulate Matter and Acidic Substances Budgets</a>	MCNC-North Carolina Supercomputing Center	Rohit Mathur, Uma Shankar, Carlie J. Coats, John McHenry, and Marc Houyoux	Paul Shapiro	\$488,744	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
40	68D50089	<a href="#">Method for Direct Continuous Monitoring of Particulate Emissions from Industrial Effluents</a>	LSR Technologies, Inc.	Dr. ZhenWu Lin	none	\$65,000	September 1995 - March 1996	<a href="#">Highlighted</a>

41	R827353C002	<a href="#">Quantifying Exposure Error and its Effect on Epidemiological Studies</a>	Harvard University	Helen Suh	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
42	R826782	<a href="#">Airborne Particulate Matter-Induced Lung Inflammation</a>	University of Texas Houston Health Science Center	Andrij Holian, Maria T. Morandi, Edwin Parsley	Deran Pashayan	\$674,288	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
43	R825271	<a href="#">An Evaluation of Confounders in PM10/Mortality Associations</a>	New York University Medical Center	Kazuhiko Ito	Deran Pashayan	\$363,394	November 25, 1996 - November, 24, 1999	<a href="#">Highlighted</a>
44	R827027	<a href="#">Research on Asthma</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
45	R826770	<a href="#">Development of Techniques for Assimilating GOES Satellite Data into Regional-Scale Photochemical Models</a>	University of Alabama in Huntsville	R. T. McNider, W. B. Norris, and S. A. Christopher	Paul Shapiro	\$404,127	July 1, 1998 - June 30, 2001	<a href="#">Highlighted</a>
46	GF-95-01349	<a href="#">Experimental Studies of the Factors Controlling the Water Nucleating Ability of Atmospheric Particulate Matter</a>	Colorado State University	Fredrick J. Brechtel	Virginia Broadway	\$25,446	9/1/95	<a href="#">Highlighted</a>
47	R827353C003	<a href="#">Differentiating Health Effects of Particles from Outdoor and Indoor Sources</a>	Harvard University	Diane Gold, Peter Stone	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
48	R824791	<a href="#">Distribution of H+ and Trace Metals in Ultrafine Ambient Aerosol</a>	New York University Medical Center	Beverly S. Cohen	Deran Pashayan	\$589,560	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>

49	R829215	<a href="#">Health Effects of Airborne Particulate Matter and Gasses</a>	University of California, Davis, Davis, CA (1); University of Utah, Salt Lake City, UT (2); and Utah State University, Logan, UT (3)	(3)	Stacey Katz/Gail Robarge	\$833,481	October 1, 2001 - September 30, 2004	<a href="#">Highlighted</a>
50	R826779	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	Harvard University	Lester Kobzik, Petros Koutrakis, Stephanie Shore, Beatriz Gonzalez-Flecha	Deran Pashayan	\$557,340	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
51	R826772	<a href="#">Improved Photolytic Rate Measurements at PAMS Sites</a>	Georgia Institute of Technology	Michael O. Rodgers and James R. Pearson	Paul Shapiro	\$168,930	March 22, 1999 - March 21, 2001	<a href="#">Highlighted</a>
52	R828170	<a href="#">Control of Mercury Emissions from Coal Combustion Sources</a>	University of Connecticut, University of Utah	Joseph J. Helble, Adel F. Sarofim,	Paul Shapiro	\$224,642	July 1, 2000 - June 30, 2002	<a href="#">Highlighted</a>
53	R826234	<a href="#">Real-time Measurement of the Size and Composition of Atmospheric Particulate Matter</a>	University of Delaware	Anthony S. Wexler	Paul Shapiro	\$374,833	December 15, 1997 - December 14, 2000	<a href="#">Highlighted</a>
54	R828172	<a href="#">Eddy-Correlation Measurement of Size-Segregated and Composition-Resolved Aerosol Depositional Flux Using an Aerosol Mass Spectrometer</a>	Massachusetts Institute of Technology	Kenneth A. Smith	Paul Shapiro	\$225,000	July 24, 2000 - July 23, 2002	<a href="#">Highlighted</a>
55	R823514	<a href="#">Formation and Physical Properties of Secondary Organic Aerosol</a>	Carnegie Mellon University	Spyros N. Pandis	Paul Shapiro	\$382,668	September 28, 1995 - September 27, 1998	<a href="#">Highlighted</a>
56	R826781	<a href="#">Human Health Effects of Exposure to Ultrafine Particles</a>	University of Rochester School of Medicine and Dentistry	Mark W. Frampton, Mark J. Utell, Gunter Oberdorster, Victor Marder, Wojciech Zareba	Deran Pashayan	\$736,260	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>

57	R826609	<a href="#">The Role of Locational Equilibria and Collective Behavior in Measuring the Benefits of Air Pollution Policies</a>	Duke University	V. Kerry Smith and Holger Sieg	Matthew Clark	\$199,948	September 1, 1998 - August 31, 2001	<a href="#">Highlighted</a>
58	R827353	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	Harvard University	Petros Koutrakis [petros@hspph.harvard.edu] (Center Director), John J. Godleski, (Center Co-Director), Joel Schwartz, (Center Co-Director), Douglas W. Dockery, Frank E. Speizer, Helen H. Suh, Diane R. Gold, Richard L. Verrier, James Ware, Paul Catalano, Jo	Stacey Katz	\$7,747,040	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
59	R826767	<a href="#">Aerosol Partitioning and Heterogeneous Chemistry</a>	The University of North Carolina at Chapel Hill	Roger E. Miller and Cindy DeForest Hauser	Paul Shapiro	\$338,749	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
60	R825305	<a href="#">Development of a Continuous Monitoring System for PM10 and Components of PM2.5</a>	New York University Medical Center	Morton Lippmann	Bill Stelz	\$436,262	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
61	R826786	<a href="#">Characterization of Factors Determining Personal Exposure to Volatile Air Toxics in Urban Environments</a>	University of Oklahoma Health Sciences Center	N.A. Esmen, T.A. Hall, D.L. Johnson, and M.L. Phillips	Deran Pashayan	\$559,352	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
62	R826778	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	Lovelace Biomedical and Environmental Research Institute (NM)	Janet M. Benson (PI), Edward B. Barr, David E. Bice, Yung-Sung Cheng, Joe L. Mauderly	Deran Pashayan	\$199,035	October 1, 1977 - September 30, 1999	<a href="#">Highlighted</a>

63	R827058	<a href="#">Time-Relevant Communication of Ozone and Particulate Air Pollution Data: A Pilot Project to Raise Public Awareness and Promote Exposure Reduction</a>	Suffolk County Conservation District, Massachusetts	Matthew Goode, Suffolk County Conservation District; Lee Alter, Northeast States for Coordinated Air Use Management; Petros Koutrakis, Harvard School of Public Health; Penn Loh, Alternatives for Community & Environment; Nancy Seidman, Massachusetts De	Madalene Stevens	\$527,000	November 1, 1998 - October 31, 2000	<a href="#">Highlighted</a>
64	R826769	<a href="#">A Portable Device for Real-Time Measurement of the Size and Composition of Atmospheric Aerosols</a>	University of Delaware1; New Mexico State University2	Murray V. Johnston1 and Gary A. Eiceman2	Paul Shapiro	\$580,963	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
65	R827995	<a href="#">Health Effects of Concentrated Ambient Particles from the Central Valley of California</a>	University of California, Davis; University of Southern California	Kent E. Pinkerton; Constantinos Sioutas	Deran Pashayan	\$633,328	02/01/2000 to 01/31/2003	<a href="#">Highlighted</a>
66	none	<a href="#">Experimental and Modeling Studies of Chlorocarbon Incineration, PIC Formation, and Emissions Control</a>	New Jersey Institute of Technology	Robert B. Barat and Joseph Bozzelli	none	none	none	<a href="#">Highlighted</a>
67	none	<a href="#">China - Innovative Waste Composting Plan for the City of Benxi, People's Rupublic of China</a>	Urban Waste Management & Research Center	John N. Crisp, Ph.D., P.E., Professor, College of Engineering	none	none	none	<a href="#">Highlighted</a>
68	R827993	<a href="#">Relationship Between PM2.5 Semi-volatile Organic Material, Other PM2.5 Components and Heart Rate Variability in The Elderly</a>	Brigham Young University	Delbert J. Eatough, C. Arden Pope III	Deran Pashayan	\$797,013	02/01/2000 to 01/31/2003	<a href="#">Highlighted</a>

69	R824970	<a href="#">Experimental Investigation of the Evolution of the Size and Composition Distribution of Atmospheric Organic Aerosols</a>	California Institute of Technology	Glen Cass	Paul Shapiro	\$75,000.00	05/31/98 ending date	<a href="#">Highlighted</a>
70	R827354	<a href="#">Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</a>	University of Rochester; California Institute of Technology; University of California at Riverside; GSF - National Research Center for Environment & Health (Neuherberg, Germany); Research Triangle Institute; State University of New York at Buffalo; Univer	Gunter Oberdorster (Center Director), Mark Utell (Co-Center Director), William Beckett, Christopher Cox, Jacob Finkelstein, Mark Frampton, John Looney, Victor Marder, P. E. Morrow, Michael O'Reilly, Richard Phipps, Edward Schwarz, Barry Stripp and Wojciec	Gail Robarge	\$8,302,447	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

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Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	68D50095	<a href="#">Instrument for Monitoring Fine, Respirable Particulate Matter in Flue Gases</a>	Advanced Fuel Research, Inc.	Mr. James R. Markham	none	\$64,836	September 1995 - March 1996	<a href="#">Highlighted</a>
2	68D01008	<a href="#">Optical Monitor for Noninvasive, Chemical- and Size-Differentiated Characterization of Airborne Aerosols</a>	Air Instruments & Measurements, Inc.	Harry C. Lord III	none	\$69,783	April 2001 - September 2001	<a href="#">Highlighted</a>
3	68D99070	<a href="#">Development of a Real-Time In Situ Organic/Elemental Carbon (OC/EC) Analyzer</a>	Sunset Laboratory, Inc.	Mr. R.A. Cary	none	\$69,644	September 1999 - March 2000	<a href="#">Highlighted</a>
4	68D60057	<a href="#">Method for Direct Continuous Monitoring of Particulate Emissions from Industrial Effluents</a>	LSR Technologies, Inc.	Dr. Zhen Wu Lin	none	\$225,000	September 1996 - September 1998	<a href="#">Highlighted</a>

5	68D50089	<a href="#">Method for Direct Continuous Monitoring of Particulate Emissions from Industrial Effluents</a>	LSR Technologies, Inc.	Dr. Zhen Wu Lin	none	\$65,000	September 1995 - March 1996	<a href="#">Highlighted</a>
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## Tabular Query Results of NCER Program and Solicitation Information

**29 Abstracts are listed**

**Your Query was:**

**(PM <or> particulate) <and> (morbidity)**

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30. 2001	<a href="#">Highlighted</a>
2	R827355C005	<a href="#">Mechanisms of Toxicity of PM Using Transgenic Mouse Strains</a>	University of Washington	Daniel Luchtel, Timothy Larson; Consultants: Warren Ladiges, Joellen Lewtas	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

3	R825264	<a href="#">Acidic PM and Daily Human Mortality in Three U.S. Cities</a>	New York University Medical Center	George D. Thurston	Deran Pashayan	\$383,008	November 18, 1996 - November 17, 1999	<a href="#">Highlighted</a>
4	R826234	<a href="#">Real-time Measurement of the Size and Composition of Atmospheric Particulate Matter</a>	University of Delaware	Anthony S. Wexler	Paul Shapiro	\$374,833	December 15, 1997 - December 14, 2000	<a href="#">Highlighted</a>
5	R825702	<a href="#">Indoor-Outdoor Relationships of Airborne Particle Count and Endotoxin Concentrations</a>	National Jewish Medical and Research Center	Kevin P. Fennelly, MD, MPH	Stacey Katz	none	none	<a href="#">Highlighted</a>
6	R825267	<a href="#">Development of Population-Based Particle Exposure Models for Human Health Risk Assessment</a>	Harvard University	John D. Spengler	Deran Pashayan	\$500,065	December 2, 1996 - December 1, 1999	<a href="#">Highlighted</a>
7	R827997	<a href="#">A Source-Oriented Evaluation of the Combined Effects of Fine Particles and Copollutants</a>	Nelson Institute of Environ. Medicine, New York University School of Medicine	Kazuhiko Ito and George D. Thurston	Deran Pashayan	\$478,522	02/18/2000 to 02/17/2004	<a href="#">Highlighted</a>
8	R824790	<a href="#">Cellular Mechanisms of Pulmonary Inflammation by Environmental Particles</a>	Harvard School of Public Health	Lester Kobzik, M.D.	Deran Pashayan	\$546,895	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>

9	R827355	<a href="#">Northwest Research Center for Particulate Air Pollution and Health University of Washington</a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
10	R825268	<a href="#">Pulmonary Toxicity of Particulate Matter and Ozone</a>	New York University Medical Center	Lung Chi Chen	Deran Pashayan	\$172,446	November 18, 1996 - November 17, 1998	<a href="#">Highlighted</a>
11	R824791	<a href="#">Distribution of H+ and Trace Metals in Ultrafine Ambient Aerosol</a>	New York University Medical Center	Beverly S. Cohen	Deran Pashayan	\$589,560	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
12	R826724	<a href="#">Mechanisms Of Particulate-Induced Allergic Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Marsha Wills-Karp, Ph.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
13	R826779	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	Harvard University	Lester Kobzik, Petros Koutrakis, Stephanie Shore, Beatriz Gonzalez-Flecha	Deran Pashayan	\$557,340	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
14	R826724	<a href="#">A Randomized, Controlled Trial of Home Exposure Control in Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Peyton A. Eggleston, M.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>

15	R826782	<a href="#">Airborne Particulate Matter-Induced Lung Inflammation</a>	University of Texas Houston Health Science Center	Andrij Holian, Maria T. Morandi, Edwin Parsley	Deran Pashayan	\$674,288	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
16	R826244	<a href="#">Mechanism of PM-Induced Acute Health Effects</a>	New York University Medical Center	Terry Gordon	Deran Pashayan	\$600,799	January 23, 1998 - January 22, 2,001	<a href="#">Highlighted</a>
17	R828731	<a href="#">Implications of Climate Change for Regional Air Pollution, Health Effects and Energy Consumption Behavior</a>	The Johns Hopkins University, Baltimore, MD; George Washington University, Washington, DC	J.H. Ellis (PI-JHU) [hugh.ellis@jhu.edu], B.F. Hobbs (JHU), J.F. Patz (JHU), J. Samet (JHU), M. Schwab (JHU), F. Joutz (GW)	Bernice Smith	\$1,376,739	September 1, 2000 - August 31, 2003	<a href="#">Highlighted</a>
18	R825305	<a href="#">Development of a Continuous Monitoring System for PM10 and Components of PM2.5</a>	New York University Medical Center	Morton Lippmann	Bill Stelz	\$436,262	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
19	R826778	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	Lovelace Biomedical and Environmental Research Institute (NM)	Janet M. Benson (PI), Edward B. Barr, David E. Bice, Yung-Sung Cheng, Joe L. Mauderly	Deran Pashayan	\$199,035	October 1, 1977 - September 30, 1999	<a href="#">Highlighted</a>

20	R826783	<a href="#">Relationship of Ambient Particulate Matter to Heart Rate Variability and Cardiac Arrhythmias in Elderly Adults with Coronary Artery Disease</a>	California Office of Environmental Health Hazard Assessment (1), University of California (UC), San Francisco (2), UC Berkeley (3), UC Los Angeles (4), Eisenhower Medical Center, Rancho Mirage, CA (5)	Bart Ostro (1), Michael Lipsett (1), (2), Ira Tager (3), Mary Woo (4), Merle Bolton (5)	Deran Pashayan	\$436,964	October 1, 1998 September 30, 2000	<a href="#">Highlighted</a>
21	R828046	<a href="#">Pulmonary and Systemic Effects of Inhaled Ultrafine Particles in Senescent Rats with Cardiovascular Disease</a>	University of Rochester	Alison C.P. Elder, Jean-Philippe Couderc, Mark Frampton, Günter Oberdörster, Wojciech Zareba	Deran Pashayan	\$408,859	March 24, 2000 - March 23,2003	<a href="#">Highlighted</a>
22	R826784	<a href="#">Lung Injury from Inhaled Ultrafine Particles in Compromised Rats of Old Age: Influence of Priming and Adaptation</a>	University of Rochester (NY)	Günter Oberdörster and Jacob N. Finkelstein	Deran Pashayan	\$606,545	September 21, 1998 September 20, 2001	<a href="#">Highlighted</a>
23	R827353C002	<a href="#">Quantifying Exposure Error and its Effect on Epidemiological Studies</a>	Harvard University	Helen Suh	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

24	R827352	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	University of California at Los Angeles; California Institute of Technology; Rancho Los Amigos Medical Center; University of California at Irvine; University of California at Riverside; University of Southern California	John R. Froines [jfroines@ucla.edu] (Center Director), Steven D. Colome (Co-Center Director) and Richard P. Turco (Co-Center Director), Arthur K. Cho, Yoram Cohen, Annmarie Eldering, Sheldon K. Friedlander, Stella C. Grosser, Oliver Hankinson, William C.	Stacey Katz	\$8,715,583	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
25	R827999	<a href="#">Acute Cardiopulmonary Responses to Fine Particulate Pollution and Copollutant Oxidant Gase in Los Angeles</a>	Rancho Los Amigos National Rehabilitation Center; University of Southern California	Henry Gong, Jr.; Constantinos Sioutas	Deran Pashayan	\$613,894	03/15/2000 to 03/14/2003	<a href="#">Highlighted</a>
26	R827354	<a href="#">Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</a>	University of Rochester; California Institute of Technology; University of California at Riverside; GSF - National Research Center for Environment & Health (Neuherberg, Germany); Research Triangle Institute; State	Gunter Oberdorster (Center Director), Mark Utell (Co-Center Director), William Beckett, Christopher Cox, Jacob Finkelstein, Mark Frampton, John Looney, Victor Marder, P. E. Morrow, Michael O'Reilly, Richard Phipps, Edward Schwarz, Barry Stripp and Wojciec	Gail Robarge	\$8,302,447	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

			University of New York at Buffalo; Univer					
27	R829214	<a href="#">Mechanisms of Air Pollutant-induced Pulmonary Inflammation; Effects of Zinc on EGFR Receptor Function</a>	University of North Carolina, Chapel Hill, NC	Lee M. Graves (lmg@med.unc.edu), Weidong Wu	Gail Robarge/Stacey Katz	\$874,125	November 19, 2001 - November 18, 2004	<a href="#">Highlighted</a>
28	R827996	<a href="#">Inhalability of Particulate Matter in Laboratory Animals</a>	Chemical Industry Institute of Toxicology	Bahman Asgharian	Deran Pashayan	\$335,903	01/17/2000 to 01/16/2002	<a href="#">Highlighted</a>
29	R827351	<a href="#">Health Risks of PM Components</a>	New York University School of Medicine; University of Iowa	Morton Lippmann [lippmann@charlotte.med.nyu.edu] (Center Director), Richard B. Schlesinger (Co-Center Director), Beverly S. Cohen, Terry Gordon, Joan Reibman, George D. Thurston, Lung Chi Chen, Kazuhiko K. Ito, Christine C. Nadziejko, Judith T. Zelikoff,M	Gail Robarge	\$8,076,438	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

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## Tabular Query Results of NCER Program and Solicitation Information

**43 Abstracts are listed**

**Your Query was:**

**(PM <or> particulate) <and> (mortality)**

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R826245	<a href="#">The Relative Associations of Transition Metals and Sources of Fine Particulate Matter to Increased Daily Mortality</a>	Harvard University, School of Public Health	Joel Schwartz	Deran Pashayan	\$ 211,733	January 14, 1998 - January 13, 2,000	<a href="#">Highlighted</a>
2	R825264	<a href="#">Acidic PM and Daily Human Mortality in Three U.S. Cities</a>	New York University Medical Center	George D. Thurston	Deran Pashayan	\$383,008	November 18, 1996 - November 17, 1999	<a href="#">Highlighted</a>

3	R825242	<a href="#">Pathophysiologic Mechanisms of Mortality Associated with Exposure to Concentrated Particulate Urban Air Toxics</a>	Harvard University	John J. Godleski	Deran Pashayan	\$520,997	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
4	R827355C001	<a href="#">Epidemiologic Study of Particulate Matter and Cardiopulmonary Mortality</a>	University of Washington	Joel Kaufman, Harvey Checkoway, Lianne Sheppard, David Siscovick, Jane Koenig	Joel Kaufman, Harvey Checkoway, Lianne Sheppard, David Siscovick, Jane Koenig	none	Gail Robarge/Stacey Katz	<a href="#">Highlighted</a>
5	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
6	R827355C005	<a href="#">Mechanisms of Toxicity of PM Using Transgenic Mouse Strains</a>	University of Washington	Daniel Luchtel, Timothy Larson; Consultants: Warren Ladiges, Joellen Lewtas	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
7	R827353C005	<a href="#">Assessing Life-Shortening Associated with Exposure to Particulate Matter</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
8	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30. 2001	<a href="#">Highlighted</a>

9	R827997	<a href="#">A Source-Oriented Evaluation of the Combined Effects of Fine Particles and Copollutants</a>	Nelson Institute of Environ. Medicine, New York University School of Medicine	Kazuhiko Ito and George D. Thurston	Deran Pashayan	\$478,522	02/18/2000 to 02/17/2004	<a href="#">Highlighted</a>
10	R827355	<a href="#">Northwest Research Center for Particulate Air Pollution and Health University of Washington</a>	University of Washington; Washington State University	Jane Q. Koenig [jkoenig@u.washington.edu] (Center Director), Dave Kalman (Deputy Center Director), Harvey Checkoway, David Covert, Joel Kaufman, Terry Kavanagh, Timothy V. Larson, Sally Liu, Daniel L Luchtel, Thomas Lumley, Michael Rosenfeld, Lianne Shepp	Stacey Katz	\$8,288,977	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
11	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	Harvard University	John Godleski	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
12	R826244	<a href="#">Mechanism of PM-Induced Acute Health Effects</a>	New York University Medical Center	Terry Gordon	Deran Pashayan	\$600,799	January 23, 1998 - January 22, 2,001	<a href="#">Highlighted</a>
13	R825271	<a href="#">An Evaluation of Confounders in PM10/Mortality Associations</a>	New York University Medical Center	Kazuhiko Ito	Deran Pashayan	\$363,394	November 25, 1996 - November, 24, 1999	<a href="#">Highlighted</a>
14	R824791	<a href="#">Distribution of H+ and Trace Metals in Ultrafine Ambient Aerosol</a>	New York University Medical Center	Beverly S. Cohen	Deran Pashayan	\$589,560	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>

15	R826783	<a href="#">Relationship of Ambient Particulate Matter to Heart Rate Variability and Cardiac Arrhythmias in Elderly Adults with Coronary Artery Disease</a>	California Office of Environmental Health Hazard Assessment (1), University of California (UC), San Francisco (2), UC Berkeley (3), UC Los Angeles (4), Eisenhower Medical Center, Rancho Mirage, CA (5)	Bart Ostro (1), Michael Lipsett (1), (2), Ira Tager (3), Mary Woo (4), Merle Bolton (5)	Deran Pashayan	\$436,964	October 1, 1998 September 30, 2000	<a href="#">Highlighted</a>
16	R826234	<a href="#">Real-time Measurement of the Size and Composition of Atmospheric Particulate Matter</a>	University of Delaware	Anthony S. Wexler	Paul Shapiro	\$374,833	December 15, 1997 - December 14, 2000	<a href="#">Highlighted</a>
17	R827998	<a href="#">Health Effects of long-Term Exposure to Particles and Other Air Pollutants in Elderly Nonsmoking California Residents</a>	Loma Linda University	Synnove F. Knutsen, David E Abbey and Larry Beeson	Deran Pashayan	\$763,910	March 1, 2000 -- February 28, 2003	<a href="#">Highlighted</a>
18	R825702	<a href="#">Indoor-Outdoor Relationships of Airborne Particle Count and Endotoxin Concentrations</a>	National Jewish Medical and Research Center	Kevin P. Fennelly, MD, MPH	Stacey Katz	none	none	<a href="#">Highlighted</a>

19	R825267	<a href="#">Development of Population-Based Particle Exposure Models for Human Health Risk Assessment</a>	Harvard University	John D. Spengler	Deran Pashayan	\$500,065	December 2, 1996 - December 1, 1999	<a href="#">Highlighted</a>
20	R824790	<a href="#">Cellular Mechanisms of Pulmonary Inflammation by Environmental Particles</a>	Harvard School of Public Health	Lester Kobzik, M.D.	Deran Pashayan	\$546,895	October 1, 1995 - September 30, 1998	<a href="#">Highlighted</a>
21	R825268	<a href="#">Pulmonary Toxicity of Particulate Matter and Ozone</a>	New York University Medical Center	Lung Chi Chen	Deran Pashayan	\$172,446	November 18, 1996 - November 17, 1998	<a href="#">Highlighted</a>
22	R826780	<a href="#">Cardiovascular Vulnerability to Particulate Pollution</a>	Harvard School of Public Health	Diane R. Gold, Peter Stone, Augusto Litonjua; Richard Verrier, Joel Schwartz	Deran Pashayan	\$648,227	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
23	R827355C003	<a href="#">Personal PM Exposure Assessment</a>	University of Washington, Washington State University	L-J Sally Liu, Candis Claiborn, Lara Gundel, Timothy Larson	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
24	U91-5361	<a href="#">Studies of Aerosol Composition, Partitioning and Heterogeneous Chemistry using Infrared Spectroscopy</a>	University of North Carolina at Chapel Hill	Cindy DeForest Hauser	Georgette Boddie	22,978	8/16/98	<a href="#">Highlighted</a>
25	R826782	<a href="#">Airborne Particulate Matter-Induced Lung Inflammation</a>	University of Texas Houston Health Science Center	Andrij Holian, Maria T. Morandi, Edwin Parsley	Deran Pashayan	\$674,288	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>

26	R828731	<a href="#">Implications of Climate Change for Regional Air Pollution, Health Effects and Energy Consumption Behavior</a>	The Johns Hopkins University, Baltimore, MD; George Washington University, Washington, DC	J.H. Ellis (PI-JHU) [hugh.ellis@jhu.edu], B.F. Hobbs (JHU), J.F. Patz (JHU), J. Samet (JHU), M. Schwab (JHU), F. Joutz (GW)	Bernice Smith	\$1,376,739	September 1, 2000 - August 31, 2003	<a href="#">Highlighted</a>
27	R827353	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	Harvard University	Petros Koutrakis [petros@hsph.harvard.edu] (Center Director), John J. Godleski, (Center Co-Director), Joel Schwartz, (Center Co-Director), Douglas W. Dockery, Frank E. Speizer, Helen H. Suh, Diane R. Gold, Richard L. Verrier, James Ware, Paul Catalano, Jo	Stacey Katz	\$7,747,040	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
28	R825305	<a href="#">Development of a Continuous Monitoring System for PM10 and Components of PM2.5</a>	New York University Medical Center	Morton Lippmann	Bill Stelz	\$436,262	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
29	R827353C006	<a href="#">Investigating Chronic Effects of Exposure to Particulate Matter</a>	Harvard University	Douglas Dockery	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
30	R826778	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	Lovelace Biomedical and Environmental Research Institute (NM)	Janet M. Benson (PI), Edward B. Barr, David E. Bice, Yung-Sung Cheng, Joe L. Mauderly	Deran Pashayan	\$199,035	October 1, 1977 - September 30, 1999	<a href="#">Highlighted</a>

	31	R828046	<a href="#">Pulmonary and Systemic Effects of Inhaled Ultrafine Particles in Senescent Rats with Cardiovascular Disease</a>	University of Rochester	Alison C.P. Elder, Jean-Philippe Couderc, Mark Frampton, G <sup>3</sup> nter Oberdörster, Wojciech Zareba	Deran Pashayan	\$408,859	March 24, 2000 - March 23,2003	<a href="#">Highlighted</a>
	32	R826784	<a href="#">Lung Injury from Inhaled Ultrafine Particles in Compromised Rats of Old Age: Influence of Priming and Adaptation</a>	University of Rochester (NY)	Günter Oberdörster and Jacob N. Finkelstein	Deran Pashayan	\$606,545	September 21, 1998 September 20, 2001	<a href="#">Highlighted</a>
	33	R827353C002	<a href="#">Quantifying Exposure Error and its Effect on Epidemiological Studies</a>	Harvard University	Helen Suh	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	34	R828686	<a href="#">Spatial and Temporal Models for Environmental Health Effects</a>	Duke University, Durham, NC	Merlise Clyde (clyde@stat.duke.edu)	Chris Saint	\$557,859	February 12, 2001 - February 11, 2004	<a href="#">Highlighted</a>
	35	R827352	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	University of California at Los Angeles; California Institute of Technology; Rancho Los Amigos Medical Center; University of California at Irvine; University of California at Riverside; University of Southern California	John R. Froines [jfroines@ucla.edu] (Center Director), Steven D. Colome (Co-Center Director) and Richard P. Turco (Co-Center Director), Arthur K. Cho, Yoram Cohen, Annmarie Eldering, Sheldon K. Friedlander, Stella C. Grosser, Oliver Hankinson, William C.	Stacey Katz	\$8,715,583	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>

36	R827999	<a href="#">Acute Cardiopulmonary Responses to Fine Particulate Pollution and Copollutant Oxidant Gase in Los Angeles</a>	Rancho Los Amigos National Rehabilitation Center; University of Southern California	Henry Gong, Jr.; Constantinos Sioutas	Deran Pashayan	\$613,894	03/15/2000 to 03/14/2003	<a href="#">Highlighted</a>
37	R829214	<a href="#">Mechanisms of Air Pollutant-induced Pulmonary Inflammation; Effects of Zinc on EGFR Receptor Function</a>	University of North Carolina, Chapel Hill, NC	Lee M. Graves (lmg@med.unc.edu), Weidong Wu	Gail Robarge/Stacey Katz	\$874,125	November 19, 2001 û November 18, 2004	<a href="#">Highlighted</a>
38	R827996	<a href="#">Inhalability of Particulate Matter in Laboratory Animals</a>	Chemical Industry Institute of Toxicology	Bahman Asgharian	Deran Pashayan	\$335,903	01/17/2000 to 01/16/2002	<a href="#">Highlighted</a>
39	R827993	<a href="#">Relationship Between PM2.5 Semi-volatile Organic Material, Other PM2.5 Components and Heart Rate Variability in The Elderly</a>	Brigham Young University	Delbert J. Eatough, C. Arden Pope III	Deran Pashayan	\$797,013	02/01/2000 to 01/31/2003	<a href="#">Highlighted</a>
40	none	<a href="#">Investigation of the Formation of Particulate Matter in Spark-Ignited Engines</a>	Massachusetts Institute of Technology	Simone Hochgreb and Arthur Lafleur	none	\$75,000.00	06/30/99 ending date	<a href="#">Highlighted</a>

41	R827354	<a href="#">Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</a>	University of Rochester; California Institute of Technology; University of California at Riverside; GSF - National Research Center for Environment & Health (Neuherberg, Germany); Research Triangle Institute; State University of New York at Buffalo; Univer	Gunter Oberdorster (Center Director), Mark Utell (Co-Center Director), William Beckett, Christopher Cox, Jacob Finkelstein, Mark Frampton, John Looney, Victor Marder, P. E. Morrow, Michael O'Reilly, Richard Phipps, Edward Schwarz, Barry Stripp and Wojciec	Gail Robarge	\$8,302,447	June 1, 1999 - May 30, 2004	<a href="#">Highlighted</a>
42	R827351	<a href="#">Health Risks of PM Components</a>	New York University School of Medicine; University of Iowa	Morton Lippmann [lippmann@charlotte.med.nyu.edu] (Center Director), Richard B. Schlesinger (Co-Center Director), Beverly S. Cohen, Terry Gordon, Joan Reibman, George D. Thurston, Lung Chi Chen, Kazuhiko K. Ito, Christine C. Nadziejko, Judith T. Zelikoff,M	Gail Robarge	\$8,076,438	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
43	none	<a href="#">Eutrophication of Coral Reefs</a>	none	Rafael A. Olivieri	none	none	none	<a href="#">Highlighted</a>

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**37 Abstracts are listed**

**Your Query was:**

(PM **<or>** particulate) **<and>** (sensitive population **<or>** child\* **<or>** pregnant **<or>** elderly **<or>** diabetic\* **<or>** asthma)  
**<and> <not>** (administrative core)

Number	Identifier	Abstract	Institution	Principal Investigator	Grant Representative	Grant Amount	Proposed Start Date	Highlighted Result?
1	R826779	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	Harvard University	Lester Kobzik, Petros Koutrakis, Stephanie Shore, Beatriz Gonzalez-Flecha	Deran Pashayan	\$557,340	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>
2	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	University of Arizona	Michael Lebowitz, M.K. O'Rourke	Deran Pashayan	\$363,426	October 1, 1998 - September 30, 2001	<a href="#">Highlighted</a>

	3	R826724	<a href="#">Mechanisms Of Particulate-Induced Allergic Asthma</a>	The Johns Hopkins University Center For The Asthmatic Child in the Urban Environment; Johns Hopkins University	Dr. Peyton Eggleston , MD; Marsha Wills-Karp, Ph.D.	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	4	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	5	R827353C005	<a href="#">Assessing Life-Shortening Associated with Exposure to Particulate Matter</a>	Harvard University	Joel Schwartz	Gail Robarge/Stacey Katz	none	June 1, 1999-May 31, 2004	<a href="#">Highlighted</a>
	6	R829216	<a href="#">Effects of Airborne Particles on Allergic Airway Disease</a>	(1)Michigan State University, East Lansing, MI; (2)University of Southern California and the Southern California Particle Center and Supersite, Los Angeles, CA	Jack Harkema, DVM, Ph.D., (PI) [harkemaj@msu.edu](1); Constantinos Sioutas, Ph.D. (Co-PI)(2)	Gail Robarge/Stacey Katz	\$854,702	October 31, 2001 û October 30, 2004	<a href="#">Highlighted</a>
	7	R827355C002	<a href="#">Health Effects of PM in Susceptible Populations</a>	University of Washington	Jane Q. Koenig, Joel Kaufman, Carol Trenga, Jeff Sullivan, Sally Liu, Tim Larson, Lianne Sheppard, Thomas Lumley, Karen Jansen	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>

8	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	Harvard University	John Godleski	Gail Robarge/Stacey Katz	none	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
9	R825266	<a href="#">Air Pollution and Hospital Admissions in Washington State</a>	Fred Hutchinson Cancer Research Center	Suresh H. Moolgavkar	Deran Pashayan	\$420,056	October 1, 1996 - September 30, 1999	<a href="#">Highlighted</a>
10	R825265	<a href="#">Ultrafine Particles in Urban and Respiratory Health Among Children with Respiratory Symptoms</a>	Harvard University	Joel Schwartz	Deran Pashayan	\$196,185	December 2, 1996 - December 1, 1999	<a href="#">Highlighted</a>
11	R825275	<a href="#">Asthma Indices Associated with Ambient Submicron Particles and Formaldehyde in Ambient Air Pollution</a>	National Jewish Medical and Research Center	Kevin P. Fennelly	Deran Pashayan	\$178,865	December 1, 1996 - November 30, 1997	<a href="#">Highlighted</a>
12	R829213	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	Emory University, Atlanta, GA	Paige Tolbert, Ph.D. (ptolber@sph.emory.edu); Mitchel Klein, Ph.D.; Dana Flanders, M.D.; DSc, Knox Todd, M.D.; Robert Lyles, Ph.D.; Lance Waller, Ph.D.; P. Barry Ryan, Ph.D.; James Mulholland, Ph.D.; and Armistead Russell, Ph.D.	Gail Robarge/Stacey Katz	\$1,238,940	January 1, 2002 - December 31, 2004	<a href="#">Highlighted</a>

	13	R825702	<a href="#">Indoor-Outdoor Relationships of Airborne Particle Count and Endotoxin Concentrations</a>	National Jewish Medical and Research Center	Kevin P. Fennelly, MD, MPH	Stacey Katz	none	none	<a href="#">Highlighted</a>
	14	R827353	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	Harvard University	Petros Koutrakis [petros@hsph.harvard.edu] (Center Director), John J. Godleski, (Center Co-Director), Joel Schwartz, (Center Co-Director), Douglas W. Dockery, Frank E. Speizer, Helen H. Suh, Diane R. Gold, Richard L. Verrier, James Ware, Paul Catalano, Jo	Stacey Katz	\$7,747,040	June 1, 1999 - May 31, 2004	<a href="#">Highlighted</a>
	15	R826783	<a href="#">Relationship of Ambient Particulate Matter to Heart Rate Variability and Cardiac Arrhythmias in Elderly Adults with Coronary Artery Disease</a>	California Office of Environmental Health Hazard Assessment (1), University of California (UC), San Francisco (2), UC Berkeley (3), UC Los Angeles (4), Eisenhower Medical Center, Rancho Mirage, CA (5)	Bart Ostro (1), Michael Lipsett (1), (2), Ira Tager (3), Mary Woo (4), Merle Bolton (5)	Deran Pashayan	\$436,964	October 1, 1998 September 30, 2000	<a href="#">Highlighted</a>
	16	R826785	<a href="#">Effects of Inhaled Ultrafine Particles on Asthma</a>	Lovelace Respiratory Research Institute, Albuquerque, NM.	David E. Bice, T.K. Redman, K.J. Nikula, E.B. Barr, Y.S. Cheng	Deran Pashayan	\$545,147	October 1, 1998 September 30, 2001	<a href="#">Highlighted</a>

	17	R827027	<a href="#">Research on Asthma</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>
	18	R827993	<a href="#">Relationship Between PM2.5 Semi-volatile Organic Material, Other PM2.5 Components and Heart Rate Variability in The Elderly</a>	Brigham Young University	Delbert J. Eatough, C. Arden Pope III	Deran Pashayan	\$797,013	02/01/2000 to 01/31/2003	<a href="#">Highlighted</a>
	19	R827027	<a href="#">Growth and Development: Prenatal Exposure PAH</a>	Columbia Center For Children's Environmental Health, Columbia University	Dr. Frederica Perera	Nigel Fields	\$3,600,000	1998-2002	<a href="#">Highlighted</a>

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## 1995 STAR Recipients

### Air Pollutants

Principal Investigator Department/Institution	Grant Title	Funding (\$)/ Project Period
Lester Kobzik School of Public Health Harvard Univ. (MA)	<a href="#">Cellular Mechanisms of Pulmonary Inflammation by Environmental Particles</a>	546,895/3
Beverly S. Cohen Inst. of Environmental Medicine New York Univ. Medical Center (NY)	<a href="#">Distribution of H+ and Trace Metals in Ultrafine Ambient Aerosol</a>	589,560/3
Spyros N. Pandis Dept. of Chemical Engineering Carnegie Mellon Univ. (PA)	<a href="#">Development and Testing of a State-Of-The-Art PMx Particulate Module for Regional and Urban Photochemical Models</a>	412,041/3

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Principal Investigator Department/Institution	Grant Title	Funding(\$)/ Project Period
<b>CHEMISTRY AND PHYSICS OF AIR -- Exploratory Research Grants</b>		
Jeffrey C. Weil Cooperative Inst. For Research in Environmental Sciences Univ. Of Colorado-Boulder (CO)	<a href="#">Lagrangian Modeling of Pollutant Dispersal in the Atmospheric Boundary Layer</a>	164,473/2
Spyros N. Pandos Dept. Of Chemical Engineering Carnegie Mellon Univ. (PA)	<a href="#">Formation and Physical Properties of Secondary Organic Aerosol</a>	382,668/3
Jeffrey L. Collett Dept. Of Atmospheric Science Colorado State Univ. (CO)	<a href="#">Effects of Non-Uniform Cloud Drop Composition of Pollutant Transformation and Removal in Winter Clouds</a>	339,273/3
Murray Johnston Dept. Of Chemistry Biochemistry Univ. Of Delaware (DE)	<a href="#">Speciation of Volatile and Reacting Compounds in Particulate Matter</a>	334,455/3
Bernd Simoneit College of Oceanic and Atmospheric Sciences Oregon State Univ. (OR)	<a href="#">Organic Tracers of Plant Classes in Biomass Combustion and Smoke in Aerosols</a>	196,244/2

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Principal Investigator Department/Institution	Grant Title	Funding (\$)/ Project Period
John Godelski School of Public Health Harvard University (MA)	<a href="#">Pathophysiologic Mechanisms of Mortality Associated with Exposure to Concentrated Particulate Urban Air Toxics</a>	520,997/3
John Ondov Dept. of Chemistry University of Maryland (MD)	<a href="#">Atmospheric Fate and Dry Deposition of Urban Soot to Great Waters Using a Novel, State-of-the-Art Isotopic Particulate Tracer</a>	454,976/3
Paul Davidovits Dept. of Chemistry Boston College (MA)	<a href="#">Heterogeneous Chemistry of Sub-micron Aerosols Related to Tropospheric Oxidants</a>	440,343/3
George D. Thurston Institute of Environmental Medicine New York University Medical Center (NY)	<a href="#">Acidic Particulate Matter and Daily Human Mortality in Three U.S. Cities</a>	383,008/3
Joel Schwartz School of Public Health Harvard University (MA)	<a href="#">Ultrafine Particle in Urban Air and Respiratory Health Among Children with Respiratory Symptoms</a>	196,185/3
Suresh H. Moolgavkar Division of Public Health Sciences Fred Hutchinson Cancer Research Center (WA)	<a href="#">Air Pollution and Hospital Admissions in Washington State</a>	420,056/3
Halak Ozkaynak School of Public Health Harvard University (MA)	<a href="#">Development of Population-Based Particle Exposure Models for Human Health Risk Assessment</a>	500,065/3
Lung Chi Chen Institute of Environmental Medicine New York University (NY)	<a href="#">Pulmonary Toxicity of Particulate Matter and Ozone</a>	172,446/2
John M. Ondov Dept. of Chemistry and Biochemistry University of Maryland (MD)	<a href="#">Development of a Semi-continuous Monitor for Determination of Trace Elements and Heavy Metals in Ambient Aerosol Particles</a>	395,885/3

Kazuhiko Ito Institute of Environmental Medicine New York University Medical Center (NY)	<a href="#">An Evaluation of Confounders in PM<sub>10</sub>/Mortality Associations</a>	363,394/3
Kevin P. Fennelly Dept. of Medicine National Jewish Center for Immunology and Respiratory Medicine (CO)	<a href="#">Asthma Indices Associated with Ambient Submicron Particles and Formaldehyde in Ambient Air Pollution</a>	178,865/1

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## 1997 STAR Recipients

### Health Effects and Exposures to Particulate Matter and Associated Air Pollutants

Principal Investigator Department/Institution	Grant Title	Funding(\$)/Project Period
Terry Gordon Institute of Environmental Medicine New York University Medical Center (NY)	<a href="#">Mechanism of PM-Induced Acute Health Effects</a>	\$600,799/3
Lucas M. Neas Dept. of Environmental Health Harvard College (MA)	<a href="#">The Relative Associations of Transition Metals and Sources of Fine Particulate Matter to Increased Daily Mortality</a>	\$211,733/2
Kent E. Pinkerton Institute of Toxicology and Environmental Health University of California at Davis (CA)	<a href="#">Particle Toxicity and the Respiratory Bronchiole</a>	\$525,000/3
William Reed Center for Environmental Medicine & Lung Biology University of North Carolina at Chapel Hill (NC)	<a href="#">Mechanisms of Particulate-Induced Mediator Expression in Human Airway Epithelial Cells</a>	\$374,174/3

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Principal Investigator Department/Institution	Grant Title	Funding(\$)/Project Period
Glen R. Cass Environmental Engineering Science Dept. California Institute of Technology (CA)	<a href="#">The Contribution of Biomass Combustion to Ambient Fine Particle Concentrations in the United States</a>	\$532,642/3
Sheldon K. Friedlander Dept. of Chemical Engineering University of California at Los Angeles (CA)	<a href="#">Morphological and Chemical Characteristics of the Submicron Atmospheric Aerosol: Implication for Standards</a>	\$345,247/3
Kimberly A. Prather Dept. of Chemistry University of California at Riverside (CA)	<a href="#">Real-Time Monitoring of Individual Atmospheric Aerosol Particles: Establishing Correlations between Particle Size and Chemical Speciation</a>	\$547,000/3
Anthony S. Wexler Dept. of Mechanical Engineering University of Delaware (DE)	<a href="#">Real-Time Measurement of the Size and Composition of Atmospheric Particulate Matter</a>	\$374,833/3
Paul J. Ziemann Statewide Air Pollution Research Center University of California at Riverside (CA)	<a href="#">Investigations of the Chemistry of Secondary Aerosol Formation Using Thermal Desorption Particle Beam Mass Spectrometry</a>	\$294,762/3

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## 1998 STAR Recipients

### Air Pollution Chemistry and Physics (5 recipients)

Principal Investigator Institution	Grant Title	Funding(\$)/Project Period
Panos Georgopoulos University of Medicine and Dentistry of New Jersey (NJ)	<a href="#">Modeling and Evaluation of Mechanisms Controlling the Outdoor/Indoor Relationships of Fine Particle Levels and Characteristics</a>	\$170,828/2
Roger E. Miller University of North Carolina at Chapel Hill (NC)	<a href="#">Aerosol Partitioning and Heterogeneous Chemistry</a>	\$338,749/3
Murray V. Johnston University of Delaware (DE)	<a href="#">A Portable Device for Real-Time Measurement of the Size and Composition of Atmospheric Aerosols</a>	\$580,963/3
Richard M. Kamens University of North Carolina at Chapel Hill (NC)	<a href="#">Partitioning of Semivolatile Organic Compounds in Organic and Inorganic Aerosols: A Unified Approach</a>	\$562,536/3
Rohit Mathur MCNC NC Supercomputing Center (NC)	<a href="#">A Modeling Investigation of NHx Cycling in the Troposphere and Its Impact on Particulate Matter and Acidic Substances Budgets</a>	\$488,744/3

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## 1998 STAR Recipients

### Health Effects and Exposures to Particulate Matter and Associated Air Pollutants (9 recipients)

Principal Investigator Institution	Grant Title	Funding(\$)/Project Period
Michael D. Lebowitz University of Arizona (AZ)	<a href="#">Long term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	\$363,426/3
Janet M. Benson Lovelace Biomedical and Environmental Research Inst. (NM)	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	\$199,035/1
Lester Kobzik Harvard University (MA)	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	\$557,340/3
Diane R. Gold Channing Laboratory (MA)	<a href="#">Cardiovascular Vulnerability to Particulate Pollution</a>	\$648,227/3
Mark W. Frampton University of Rochester (NY)	<a href="#">Human Health Effects of Exposure to Ultrafine Particles</a>	\$736,260/3
Andrij Holian University of Texas Health Science Center at Houston (TX)	<a href="#">Airborne Particulate Matter Induced Lung Inflammation</a>	\$674,288/3
Bart Ostro Public Health Institute (CA)	<a href="#">Relationship of Ambient Particulate Matter to heart Rate Variability and Cardiac Arrhythmias in Elderly Adults with coronary Artery Disease</a>	\$436,964/2
Guenter Oberdorster University of Rochester (NY)	<a href="#">Lung Injury from Inhaled Ultrafine Particles in Compromised Rats of Old Age: Influence of Priming and Adaptation</a>	\$606,545/3
David E. Bice Lovelace Biomedical and Environmental Research Inst. (NM)	<a href="#">Effects of Inhaled Ultrafine Particles on Asthma</a>	\$545,147/3

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## 1999 STAR Recipients

### Airborne Particulate Matter (PM) Health Effects (8 recipients)

Principal Investigator E-mail/Institution	Grant Title	Funding(\$)/Project Period
Henry Gong Rancho Los Amigos National Rehabilitation Center; University of Southern California	<a href="#">Acute Cardiopulmonary Responses to Fine Particulate Pollution and Copollutant Oxidant Gase in Los Angeles</a>	\$613,894
Kazuhiko Ito Nelson Institute of Environ. Medicine, New York University School of Medicine	<a href="#">A Source-Oriented Evaluation of the Combined Effects of Fine Particles and Copollutants</a>	\$478,522
Pinkerton University of California, Davis; University of Southern California	<a href="#">Health Effects of Concentrated Ambient Particles from the Central Valley of California</a>	\$633,328
Synnove F. Knutsen Loma Linda University	<a href="#">Health Effects of Long-Term Exposure to Particles and Other Air Pollutants in Elderly Nonsmoking California Residents and Potentially Sensitive Subgroups.</a>	\$763,910
Bahman Asgharian Chemical Industry Institute of Toxicology	<a href="#">Inhalability of Particulate Matter in Laboratory Animals</a>	\$335,903
Alison C.P. Elder University of Rochester	<a href="#">Pulmonary and Systemic Effects of Inhaled Ultrafine Particles in Senescent Rats with Cardiovascular Disease</a>	\$408,859
Delbert J. Eatough Brigham Young University	<a href="#">Relationship Between PM2.5 Semi-volatile Organic Material, Other PM2.5 Components and Heart Rate Variability in The Elderly</a>	\$797,013
Duanping Liao Pennsylvania State University	<a href="#">Cardiovascular Responses to Particulate Air Pollution</a>	\$607,630

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## 2001 STAR Recipients

### Health Effects of Particulate Matter (4 recipients)

Principal Investigator E-mail/Institution	Grant Title	Funding(\$)/Project Period
Jack Harkema <a href="mailto:harkemaj@msu.edu">harkemaj@msu.edu</a> Michigan State University	<a href="#">Effects of Airborne Particles on Allergic Airway Disease</a>	\$854,702
Lee M. Graves <a href="mailto:lmg@med.unc.edu">lmg@med.unc.edu</a> University of North Carolina	<a href="#">Mechanisms of Air Pollutant-induced Pulmonary Inflammation; Effects of Zinc on EGFR Receptor Function</a>	\$874,125
Paige Tolbert <a href="mailto:ptolber@sph.emory.edu">ptolber@sph.emory.edu</a> Emory University	<a href="#">Multiple Pollutants and Risk of Cardiac and Respiratory Emergency Department Visits in Atlanta</a>	\$1,238,940
Kent E. Pinkerton <a href="mailto:kepinkerton@ucdavis.edu">kepinkerton@ucdavis.edu</a> University of California, Davis	<a href="#">Health Effects of Airborne Particulate Matter and Gasses</a>	\$833,481

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## 1999 STAR Recipients

### Airborne Particulate Matter Centers (5 recipients)

Principal Investigator E-mail/Institution	Grant Title	Center Projects	Funding(\$)/Project Period
Petros Koutrakis Harvard University	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Biological Mechanisms/Dosimetry</a>	<a href="#">Research Projects</a>	\$7,747,040
Jane Q. Koenig University of Washington	<a href="#">Northwest Research Center for Particulate Air Pollution and Health</a>	<a href="#">Research Projects</a>	\$8,288,977
Morton Lippmann New York University School of Medicine	<a href="#">Health Risks of PM Components</a>	<a href="#">Research Projects</a>	\$8,076,438
Gunter Oberdorster University of Rochester	<a href="#">Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</a>	<a href="#">Research Projects</a>	\$8,302,447
John R. Froines University of California at Los Angeles	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	<a href="#">Research Projects</a>	\$8,715,583

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## Science Topics: Particulate Matter: Monitoring Results Synopsis

PI	Project	Year	Goals	Results	# Pubs
Cass, G.	Experimental investigation of the evolution of the size and composition distribution of atmospheric organic aerosols	2000*	Fine particulate compositional characterization	PUBLICATION 1: Average ambient fine particulate concentrations have declined; EC, CO, organics and nitrate are higher in winter; sulfate higher in summer, sulfate and EC have declined over past 15 years; nitrate and organics show no marked decline; negative measurement artifact for nitrate due to volatilization from Teflon filters. Q: Highest fine mass in winter - is that also highest hospital admissions? PUBLICATION 2: Urban areas with industrial emission sources appear to have higher mutagenicities per microgram of organic carbon with secondary pollutants playing a lesser, if any, role; if important mutagen-forming reactions occur in the atmosphere they must occur in cold as well as in warm seasons.	2 (CAO)
Chameides, W.	Southern Center for the Integrated Study of Secondary Air Pollutants (SCISSAP)	2001	Elucidation of sources and dynamics of O3 and PM2.5 ambient air concentrations in Southeastern U.S.	PUBLICATION 1: Inherent uncertainties result in differences between observations and models when using air quality models (AQMs) and suggested that all events making up spatial distribution of O3 be utilized rather than episodic events as they provide closer correlations. PUBLICATION 2: Consideration of a marine boundary layer (MBL) source of particles from H2SO4 nucleation is required to understand aerosol distribution; Aitken mode particles (20-100 nm) are observed in concentrations greater than predicted such that an additional and more constant source other than nucleation (i.e. free troposphere entrainment, horizontal diffusion or unaccounted ocean source) is apparent; the key is the highly nonlinear nature of nucleation of H2SO4 - a threshold value determines onset of nucleation process.	2
Cohen, B.	Distribution of H+ and trace metals in ultrafine ambient aerosol	1999	Develop a field method to measure the number concentration and metal content of acidic airborne ultrafine particles, and a personal monitor for ultrafine acid aerosols	FINAL REPORT: Ultrafine ambient monitor had 73% deposition efficiency for particles 50 nm and only 40% for <100 nm (particle size distribution on the detector is correlated with particle size distribution in air using efficiency (?)); 60% for 28nm and 50% for <20; higher concentrations of NH4+, SO4-2; and H+ in spring and summer vs fall and winter; nitrate concentrations very low.	3(?)

Eatough, D.	Continuous measurement of PM2.5 and associated semi-volatile particulate species	1999	Design real-time ambient mass sampler (RAMS) to avoid errors in mass determination of PM2.5 due to loss of semi-volatile material (ammonium nitrate, organics) during sampling or addition of particle-bound water	FINAL REPORT: Water minimization, good size selection; good agreement with conventional (denuder) sampler while RFM sampler has 30-40% loss of volatile mass; precision improved with change from cellulose portion of filter to glass fibers PUBLICATION 1: Ambient fine particulate concentrations (mass)are not well correlated with indoor fine particulate correlations, however ambient fine mass shows some correlation with soot and ultrafine particles. PUBLICATION 2: Development of fine particulate samplers w/ denuders (EM-, PC- and W-Boss); W-Boss has precision of + 0.8 g/m <sup>3</sup> , others poor; FRM and TEOM undermeasure PM2.5 ~20%. PUBLICATION 3: Diffusion denuder sampling system (PC-BOSS) combined with particle concentrator eliminates positive and negative sampling artifacts observed in FRM; 20% of volatilized material is ammonium nitrate and 80% fine particulate SVOC; positive artifact due to gas-phase material adsorption with 99% removal by PC-BOSS; denuder lifetime ~ few months; addition of Naflon-dryer and TEOM to PC-BOSS is RAMS.	3 + 9(?)
Friedlander, K.	Morphological and chemical characteristics of the submicron atmospheric aerosol: implication for standards	2001	To establish the prevalence and physical properties of ultrafine (<0.1 m) and accumulation (0.1 to 1.0 m) particles, to determine certain characteristics of these particles as related to health, to characterize ambient atmospheric aerosol	PUBLICATION 1: Evaluation of versatile aerosol concentration enrichment system (VACES) that enriches concentrations of ambient coarse, fine and ultrafine particles; volatile species (e.g. ammonium nitrate) are preserved; results show no occurrence of particle coagulation; results indicate that ultrafine particles collected without loss; detailed morphological examinations indicate ultrafine particles collected without substantial changes in compactness or denseness.	1 + 1(?)
Hochgreb, S.	Investigation of the formation of particulate matter in spark-ignited engines		Develop an experimental database of PM emissions (mass rate, composition, number and size distribution) from engines; develop and apply a time-resolved diagnostic for the measurement of instantaneous PM concentrations; use the developed database to characterize and quantify the important processes that control PM formation and oxidation in the engine; and develop a physical model for the PM formation and oxidation processes.	CAO WEB PAGE: At high flow rates (Re > 60,000 and residence time 0.5 sec) as dilution ratio increases, cooling increases and HC vapor condensation on existing particles increases, thereby increasing particle mass with particle concentration increasing up to a dilution ratio of 15:1 and then decreasing; at low flow rates (Re < 9,000, residence time 3.5 sec) dilution ratio does not affect temperature and hence does not affect condensation rate and as dilution ratio increases, particle concentration decreases up to 15:1 ratio, then no longer affected; particle numbers decrease by 4% due to loss on walls, but mass concentration increases by 16% due to condensation and absorption; at lean air-fuel ratios (HC emissions high) PM emissions increase in number and mass; injection of liquid fuel in cylinder increases PM formation; chemical analyses ongoing.	0
Johnston, M. R823980	Speciation of volatile and reacting compounds in particulate matter	1998	Speciation of volatile and reacting compounds into simple particles by laser desorption ionization mass spectroscopic method (particles ablated with a high energy-pulsed laser beam)	FINAL REPORT: With micron-sized particles, the surface layer is preferentially analyzed so total composition of the particle may not be determined correctly if a concentration gradient exists between the surface layer and the particle interior; recommend removal of water prior to analysis by laser desorption ionization to minimize quenching of marker ions and increase accuracy. PUBLICATION 1: NaCl/KCl and NaCl/NaNO <sub>3</sub> multicomponent aerosols observed behaving consistent with thermodynamic analysis - as relative humidity(RH) reaches the theoretical deliquescence point the chemical composition of solution on particle surface changes gradually with increasing RH until the particle completes transition to aqueous droplet; this deliquescence occurs at lower points than theory predicts - possibly due to cracks or	11

				pores on the surface; the (NH4)2SO4/NH4NO3 aerosols differed from thermodynamic predictions showing absorption of water at low RHs - possibly due to the existence of the particles as metastable aqueous droplets rather than dry particles.
Johnston, M. R823980	Speciation of volatile and reacting compounds in particulate matter	1998	Speciation of volatile and reacting compounds into simple particles by laser desorption ionization mass spectroscopic method (particles ablated with a high energy-pulsed laser beam)	PUBLICATION 2: Low laser irradiance theorized to desorb and ionize only material near the particles' surface while high laser irradiance ablates a greater fraction of the sample or the particle's surface and core areas; quantitative determination of relative amounts of nitrate and chloride could not be assessed due to large particle-to-particle variations; the increase in particle size due to addition of ammonium nitrate layer is less than the resolution of particle sizer (200 nm increase in the diameter of a 3.5 micron particle); only about 1/4 of the condensation occurs on particles; no accuracy or precision data provided. PUBLICATION 3: Matrix-Assisted laser desorption/ionization (MALDI) used to characterize aerosol particles - liquid and solid; in liquid matrix the analyte theorized to partition between the particle surface and bulk; in solid matrix the analyte theorized to absorb on surface and deposit there after crystallization; particles were of uniform size and composition during each experiment; salt contamination from the aerosol generator was evident, there may be solution characteristics unique to small particles ~2 microns; with solid matrix there is evidence that minor components preferentially deposit in surface layer while major components deposit in particle core.
Johnston, M. R823980	Speciation of volatile and reacting compounds in particulate matter	1998	Speciation of volatile and reacting compounds into simple particles by laser desorption ionization mass spectroscopic method (particles ablated with a high energy-pulsed laser beam)	PUBLICATION 4: Utilization of real-time ambient mass monitors allows for sampling and analysis of particles within a millisecond yielding excellent resolution of particle-to-particle variations and minimizing analyte alterations/reactions during sampling; ideally the inlet should have high transmission efficiency (avoids size bias) but inhibited due: 1) rapid acceleration of entering air stream causing larger particles to hit walls and perturbing flow, and 2) rapid expansion of flow in mass spec source region causing smaller particles to move away from center of flow stream; ideally inlet should also have high flow rates but often long capillary tubes - which have low flow rates - are used to enable particle to attain flow velocity prior to exiting and those with short tubes although flow rates are high the particles do not have sufficient time to reach velocity of the flow; for particle detection and sizing one approach uses 2 continuous laser beams tracking particles thru vacuum chamber - particle passes thru first beam and provides start pulse and after passing thru second stream a stop pulse is generated both by resultant scattered radiation with the inverse of the time difference between pulses proportional to particle velocity; with LDI-MS (laser desorption/ionization with time of flight mass spec) instantaneous detection and analysis are performed with the main problem being bulkiness or non-compatibility with portable usage.
Johnston, M. R823980	Speciation of volatile and reacting compounds in particulate matter	1998	Speciation of volatile and reacting compounds into simple particles by laser desorption ionization mass spectroscopic method (particles ablated with a high energy-pulsed laser beam)	PUBLICATION 5: The mass spectra of single aerosol particles found to vary with humidity in 1 or 3 ways; depending on species: 1) sharp transition between a "wet"-particle spectrum and a "dry"-particle spectrum over a narrow humidity range (65-70 %) for sodium and ammonium chloride, 2) gradual spectral transformation over a broad humidity range (7 - 70%) for ammonium nitrate, and methanesulfonic acid, and 3) no spectral change with humidity for ammonium sulfate; wet particles yield very different spectra from their dry counterparts and signal quenching in wet particle spectra can be severe in multi-component aerosol compositions; in mixed compositions only nitrate and chloride could be unambiguously identified. PUBLICATION 6: On-line and real-time analysis of particles through nozzles

				may have biased results especially surface chemical characterizations due to condensation of vapors onto particles; increasing lag time (difference between particle residence time and fluid residence time) and capillary length increases condensation; condensation of water vapor is the main source; particle condensation can be significant even for low vapor concentrations and low surface accommodations; one possible solution is to dry carrier gas prior to sampling but this may affect aqueous particle compositions; with certain industrial sampling the presence of other volatile species in large amounts may contribute to particle growth as well. PUBLICATION 7*: Positive ion mass spectra of ultrafine particles are similar to those of micron size particles although ultrafine particles may have lower cluster signal intensities, ultrafine particles produce few (or none) atomic or molecular negative ions with electron emission occurring instead; positive ion signal intensities decrease only slightly with decreasing particle size; a small particle exhibits a higher ion yield than a large particle due to greater fraction of particle vaporized and lower probability of positive-negative charge recombination. (*See Wexler)	
Kinney, P.	Columbia personal exposure study	2000	Characterize levels of and relationship among personal, indoor, and outdoor urban air toxics, using 2 high schools - 1 in New York city and the other in Los Angeles, monitoring of PM2.5 (mass and metal concentrations), VOCs and aldehydes, field work expected to be completed by the end of 2000	Ongoing (Mickey Leland Center)	6(?)
Koutrakis, P. R825336	Development and Validation of a Novel Technique to Measure Ambient Particle Properties: Bound Water, Mass, Density, and Mean Diameter	1999	Develop and test - in an urban atmosphere - a continuous mass sampler for determination of mass, density, mean diameter and bound water	PUBLICATION 1: In general pressure drop decreases slightly with particle size from 0.2 to 1.0 microns for any given pore size and face velocity - indicating pressure drop (PD) is independent of size in this range; there is a sharp increase in PD as particle size gets smaller than 0.2 microns; there is a sharp decrease in PD as particle size gets larger than 1.0 micron due to impaction; particle deposition on pore edges (main mechanism for increasing PD with time) increases with size also overall smaller particles have larger overall surface area so these effects tend to cancel; PD is inversely related to the square root of particle density; PD nearly doubles as humidity decreases (33 - 10%) possibly due to greater deposition via electrostatic mechanisms; at higher humidities (33 - 40 %) greater PD due to loading of liquid particles; for hygroscopic particles with humidities from 10 - 50 % PD decreases dramatically; the increase in PD with particle loading can be used to measure particle concentration when particle density and size are known. PUBLICATION 2 (Abstract Only): A Continuous Ambient Mass Monitor (CAMM) was developed that uses fibrous (Fluropore®) filter and compared to FRM that uses Teflon® filter; CAMM uses filter tape transportation system allowing for several weeks of sampling - 1 hr periods; CAMM has minimum volatilization and adsorption artifacts and allows for control of relative humidity; ambient air in 6 urban cities was sampled; NH4NO3, NH4SO4, elemental and organic carbon and metal oxides were measured.	3 + 3(?)

Koutrakis, P. R825270	Development and Evaluation of a Novel Sampling Method to Determine the Phase Partitioning of Semi-Volatile Organic Compounds	2000	Develop and evaluate sampling method that separates particulate and gas phases of semi-volatile organic compounds and minimizes reactions during sampling of collected material with any reactive gases (O <sub>3</sub> , HNO <sub>3</sub> , HONO, and SO <sub>2</sub> ) that might be present	PUBLICATION 2: Particle losses due to bounce-off and re-entrainment were minimized with this high volume inertial impactor; particles were collected on a polyurethane foam; polyurethane foam is inert and nontoxic; the sampler can operate for a few hours or for a week or more; this sampler can be used in exposure and/or source apportionment studies because it collects lots of particles in a short time; however for trace organics and biological and toxicological information long time periods are best; solvent extract volumes required for particle recovery are smaller than with conventional fine samplers.	2 + 2(?)
Lippman, M.	Development of a continuous monitoring system for PM10 and components of PM2.5	2000	Develop a PM mass monitor for: ultrafine particles; PM2.5; PM10; NH <sub>4</sub> NO <sub>3</sub> ; particle-bound water; and organic compounds	FINAL REPORT: The monitor reduces negative (from volatilization) and positive (from adsorbed water) artifacts in sampling; has 3 size-fractions: coarse (PM2.5-10), accumulation mode (PM0.15-2.5), and ultrafine (PM0.15 and smaller); good precision and efficiency.	1(?)
Ondov, J. R825269	Development of a semi-continuous monitor for determination of trace elements and heavy metals in ambient aerosol particles	1999	Develop a semi-continuous system for determining concentrations of various elemental components of fine particles	FINAL REPORT: The monitor found to be accurate multi-element aerosol particle sampler with data down to a 30-minute resolution scale; collection efficiency ~ 95%. PUBLICATION 1: Monitor developed for collection of particles from 0.5 to 2.5 microns had an efficiency > 80%; flow rate is 50 L/min 45 or 60 minutes (FRM is 15.7 L/m <sup>3</sup> for 24 hours); particles collected in a slurry at < 0.1 mL/min and can then be analyzed via furnace atomic spectrometry or inductively coupled plasma mass spectrometry.	1 + 3(?)
Ondov, J. R825247	Atmospheric fate and dry deposition of urban soot to Great Waters using a novel, state-of-the-art particulate tracer	1999	Develop optimum tracer techniques to investigate behavior and deposition characteristics of soot particles	FINAL REPORT: Measurement precision of + 0.2% for ambient aerosol samples with 1-10 pg of Iridium (Ir) and a detection limit of 150 fg was obtained using isotope dilution mass spectrometry; analysis by instrumental neutron activation analyzers (INAA) resulted in a precision of + 0.5% and a detection limit of 90 fg; no additional benefit from use of radiochemical neutron activation analyzers (RNAA); Micro-Orifice impactors used to determine differences in size distributions of trace elements and Ir tagged soot particles; the largest errors in particle size measurement occurred at the stage with the smallest cut point, growth for certain elements was observed in fine particles (Selenium - 22.4%, Antimony - 17.8% and Zinc - 14.0%); differences in growth for Cesium were ambiguous; tracer-induced Ir concentrations in submicrometer sizes well above background but size differentiations were difficult to make; iridium concentrations were well above background levels for particles in the submicrometer range with daily variations; for particle sizes of 2.4 - 1 m the background was comparable to the tracer concentrations and was attributed to resuspension and subsequent agglomeration of tagged soot particles; observations of particles at a site downwind showed an 18% growth for submicrometer particles and a 32% growth for 2.4 m particles; large increase in size of the 2.4 particles appears to reflect differences in amounts of resuspended dust; the contribution to the ambient air of particles 2.5 m or smaller was calculated to be 64 kg per year from diesel trucks (tagged soot); the largest contribution to tagged soot mass are particles larger than 4.7 m; IR tracer particles from diesel engines; particle size differences in site downwind from another attributed to inhomogenieties in aerosol plume and differences in levels of resuspended dust; particles were traced to area steel mill, incinerator, coal-fired power plants and more remote Ohio River Valley area through size and metal content; the highest concentrations of Fe, Zn, Cs, Sb and Se associated with steel production; incineration and coal combustion observed at industrial site; short-term PM mass and metal compositions found to be spatially non-	1 + 6(?)

	Reynolds, S.	Indoor air quality in large office buildings in the Midwest	1999	To characterize indoor air quality and compare (simultaneous measurements) to outdoor air, specific parameters include CO, CO <sub>2</sub> , organics, particulates and microorganisms, psychological (perception) analyses also done	FINAL REPORT: CO <sub>2</sub> values within range associated with "non=problem" buildings; typical CO <sub>2</sub> values of 1 ppm with highest indoor value of 6 ppm and highest outdoor value of 26 ppm; no statistical difference observed between seasons; statistical difference observed between buildings except for CO <sub>2</sub> ; highest value for thermophilic bacteria 66 CFU/m <sup>3</sup> ; PM10 values ranged from 3-71 g/m <sup>3</sup> ; significant relationships between exposure to environmental pollutants and adverse health symptoms reported most prominent for males. PUBLICATION 1: Limonene (semivolatile terpenoid) shown to be a better indicator of environmental air quality (than esters, carbonyls, aliphatic and aromatic hydrocarbons) statistically; limonene was positively correlated with health symptoms; indoor limonene levels significantly higher in winter; indoor limonene from perfumes, cosmetics, beverages, fruits and cleaning agents; states in study (6 buildings) were Iowa, Minnesota and Nebraska; average indoor concentrations of limonene ~0.5 ppbv.	1 + 2(?)
	Sarofim, A.	Markers for emissions from combustion sources	1997	Develop methods for quantifying the structure and elemental composition of soot to determine potential use as signature for source of particulate carbon in ambient air	FINAL REPORT: No PO listed, no final report. PUBLICATION 1: High-resolution transmission electron microscopy (HRTEM) analyzed as potential tool to determine carbon soot morphology and variations in reactivity with changes in conversion percentage; this study showed decrease in reactivity with increasing fractional coverage or conversion whereas an earlier study found the opposite; the unclear issues identified were concentration of inorganic material in soot and number of edge versus face carbon sites. PUBLICATION 2: HRTEM with correct band filtering (software manipulation via SEMPER6P®) of the Fourier transform was necessary to obtain realistic parameter values while eliminating noise and retaining all possible interplanar spacings; the optimum intensity threshold value must be found for consistent analyses with particles of various thickness; quantifiable parameters are circularity, elongation, lateral extent, angular dependence or fringe orientation, interplanar spacing and fractional coverage. PUBLICATION 3: Examination of 3 types of soot from diesel engines used in mining - Idle, Medium and Heavy; the lateral extent mean value of fringes in Medium load was slightly less than the other 2; Interlayer spacings showed the most variation with Idle (4.2 ), Medium 94.6 ) and Heavy (3.9 ); Medium also had the largest number of fringes (486) than either Idle or Heavy (301 and 366 respectively); reasons for difference among soot not clear.	3
	Saxena, V.	Surface levels of ultraviolet-B radiation under variable conditions of tropospheric air quality and cloudiness	2000	Measure UV-B irradiance, characterize the physical-chemical properties of transported aerosol, digitize cloud cover, evaluate impact of aerosols, cloud cover and solar zenith angle on tropospheric UV-B transmission and determine differences relative to clean and polluted air.	PUBLICATION 1: Clouds can substantially reduce incoming UV-B radiation; reflection of radiation occurs and can increase radiation levels even on cloudy days when radiation exposure might be deemed to be negligible, however still less than if no clouds were present. PUBLICATION 2: A single-scattering-separate-delta-Eddington model was developed that handles both absorption in the stratosphere and anisotropic scattering within optically thin cloud layers better than conventional Eddington models and is easier to use; this method allows for determination of when scattering is important and when conventional model is good approximation (adequate for optically thin molecular scattering layers without strong absorption and for cloud or aerosol layers with optical depths > 10); this model also enables study of coupling between scattering and absorption within compositionally complex atmospheric layers. PUBLICATION 3: A dip occurs in the normalized transmission at wavelengths < 320 nm (due to coupling of multiple scattering by aerosol particles and absorption by O <sub>3</sub> and to rapidly increasing absorption coefficient of tropospheric water-soluble particles); important to note that the combination of aerosols and O <sub>3</sub> results in greater decrease in UV than a simple sum of separate influences; there is an increase in normalized	6+ 8(?)

					atmospheric transmission at wavelengths > 320 nm which implies that the radiative properties of aerosols cannot be assumed constant in the visible band of spectrum; depending on humidity levels urban aerosols reduce transmissions.
Saxena, V.	Surface levels of ultraviolet-B radiation under variable conditions of tropospheric air quality and cloudiness	2000	Measure UV-B irradiance, characterize the physical-chemical properties of transported aerosol, digitize cloud cover, evaluate impact of aerosols, cloud cover and solar zenith angle on tropospheric UV-B transmission and determine differences relative to clean and polluted air.	PUBLICATION 4: No substantial change in aerosol optical depth noted in the past 30 years comparing this data with previous; differences in optical depth shown in air masses from highly polluted versus polluted marine versus polluted continental source regions; highly polluted air masses showed lowest mean UV-B transmissions; empirical relationships developed for optical depth and UV-B transmissions; aerosol single scatter albedo varied greatly with a heavier dependence on humidity than air mass type. PUBLICATION 5: Black carbon (BC) mass concentrations averaged 217 ng/m <sup>3</sup> in polluted air, 170 ng/m <sup>3</sup> in continental air, and 66 ng/m <sup>3</sup> in marine air; higher average BC mass concentrations associated with higher influences from polluted and continental air masses; BC and cloud condensation nuclei (CCN) showed positive correlation suggesting a percentage of BC may be in form of internal mixture; the amount of BC measured in cloud water too low to significantly effect absorption of solar radiation by clouds; the amount of BC incorporated in cloud droplets is small fraction of total; the observed BC/sulfate ratios will only slightly reduce negative direct forcing by sulfate.	
Saxena, V.	Surface levels of ultraviolet-B radiation under variable conditions of tropospheric air quality and cloudiness	2000	Measure UV-B irradiance, characterize the physical-chemical properties of transported aerosol, digitize cloud cover, evaluate impact of aerosols, cloud cover and solar zenith angle on tropospheric UV-B transmission and determine differences relative to clean and polluted air.	PUBLICATION 6: When clouds are superimposed on aerosol profile with cloud drops and particles externally mixed the normalized transmission spectrum is dominated by effect of cloud drops; the influence of aerosols in external mixtures decreases with increasing optical cloud depth; when cloud drops and particles are internally mixed through coagulation the normalized transmission spectrum is still dominated by cloud drop effects unless there is an unrealistically high volume fraction of soot but the influence of aerosols increases with increasing optical cloud depth; the number density or optical depth of aerosol particles has a higher influence on magnitude and shape of transmission spectrum than variations in interstitial optical depth or volume fraction of absorbing inclusions; in continental and urban areas prone to high aerosol loadings the attenuation of clouds with optical depths of 10 or less may either increase or decrease with wavelength depending on atmospheric conditions.	
Smith, K.	Real-time analysis of PAH bound to size-resolved atmospheric particles by tandem time of flight mass spectrometers	2000	Develop and demonstrate an aerosol mass spectrometer capable of quantifying polycyclic aromatic hydrocarbons (PAHs) associated with individual size-segregated atmospheric particles in real time	PUBLICATION 1: For aerosols containing volatile and semivolatile species, the aerosol mass spectrometer developed provides good quantitative data on particle size as a function of chemical composition; aerodynamic particle diameter is determined by measuring particle velocity via time of flight (TOF); fast particle detection is through flash vaporization of volatile and semivolatile components; collection efficiency is ~ 100% for aerodynamic diameters from 70 - 500 nm; spherical and/or larger particles focused more efficiently than non-spherical and/or smaller particles; particles with insufficient mass (< ~2 x 10 <sup>-14</sup> gm) cannot be detected without averaging mass spec ion signals over many TOF periods; this method tested for pure compounds and tests must be run for multi-component compounds; measurement of mass loading as a function of aerodynamic diameter can provide more in depth and faster information than FRM; particle composition information is limited to size-resolved analyses of particle ensembles.	1 +1(?)

Weisel, C.	EOHSI personal exposure study	2000	Show relationship between personal exposure to air toxics and outdoor sources, 3 cities: Los Angeles, CA(mostly mobile sources); Houston, TX (mostly industrial point sources); and Elizabeth, NJ(mostly area and point sources) , 100 homes in each city with ambient and personal monitors, monitoring for: PM2.5 (mass and metals); VOCs and aldehydes	Field work done by 2/01, sample analyses done by 5/01. (Ongoing) Mickey Leland Center	?
Wexler, A.	Real-time measurement of the size and composition of atmospheric particulate matter	2000	Development and evaluation of a portable monitor that sizes and analyzes particles in the 10 nanometer to 2 micrometer range	PUBLICATION 1: The mass flow rate of particles exclusively depends upon a modified Reynolds number; one-dimensional models are adequate for approximating mass flow through sonic nozzles; beams produced by capillaries have lower angular spread than those by conical nozzles; in conical nozzles the beams have a sharp focal point downstream where the beam width is minimum and beams diverge sharply after focal point; in capillaries the focal point occurs within the capillary and beams subsequently straighten out; the particle size distribution in beams from conical nozzles varies sharply for different axial locations but not in capillary beams; although capillaries result in beams of low divergence they: allow lower flow rates, lower the radial acceleration near nozzle entrance, have increased nozzle clogging due to inertial deposition of particles on walls, and promote vapor condensation of particles; for nozzles of fixed geometry and operating conditions only particles in a narrow size range are efficiently transmitted hence changing geometry and conditions allows different sizes of particles to be sampled. PUBLICATION 2*: Positive ion mass spectra of ultrafine particles are similar to those of micron size particles although ultrafine particles may have lower cluster signal intensities; ultrafine particles produce few (or none) atomic or molecular negative ions with electron emission occurring instead; positive ion signal intensities decrease only slightly with decreasing particle size; a small particle exhibits a higher ion yield than a large particle due to greater fraction of particle vaporized and lower probability of positive-negative charge recombination. (*See Johnston) PUBLICATION 3: A novel technique for rapid analysis of particles from 1 m to 10 nm was developed; particles are selectively (by size) transmitted via high speed particle beams by varying nozzle pressure; as pressure goes from 760 to 3 torr, optimal particle size goes from 1.8 m to 35 nm; some concerns with negative ion spectra (dominated by free electrons); modifications can be made to achieve 10 m upper limit; efficiency is lowered by deflection by electric field formed by ion optics.	2 + 1(?)

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### NCER Workshops

- 1998 Measurement of Air Toxics Conference  
- need some detail on purpose, who participated and PM grants involved
- 2000 Measurement of Air Toxics Conference  
- need some detail on purpose, who participated and PM grants involved

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### PM Center Workshops

- [2001 "Cardiovascular Effects of Air Pollution: Potential Mechanisms and Methods of Testing" \(pdf\)](#)

The American Petroleum Institute (API) and the U.S. Environmental Protection Agency together with the University of Rochester EPA Particle Center sponsored a workshop on March 7-8, 2001 in Rochester, New York to discuss the potential mechanisms and methods of testing that should be considered in developing a coherent approach to the investigation of cardiovascular effects associated with air



pollution. The workshop brought together epidemiologists, cardiologists and toxicologists from academia, government and industry, all of whom share an interest in understanding the relationship between particulate matter and cardiovascular health. The workshop first reviewed the evidence from epidemiologic, animal and clinical studies linking PM with cardiovascular effects as well as the armamentarium of non-invasive tests available to examine these relationships. It then went on to examine the plausible mechanisms that could be responsible for such effects including neural mechanisms, plaque formation, and the role of cytokines and inflammation. In keeping with the objectives, the workshop participants were charged with reviewing the current protocols and methods used for detecting cardiovascular responses in epidemiologic and clinical studies, considering their robustness, and exploring new methodologies.

- [2001 "Issues in the Assessment of Health Impacts of Gasoline Emissions in California" \(pdf\)](#)

This workshop was co-sponsored by the UCLA Southern California Particle Center and Supersite, the California Environmental Protection Agency, and the Southern California Environmental Health Sciences Center. Topics covered included laboratory studies of toxicity of gasoline emissions, monitoring and measurement of PM, characterizing health risks, source apportionment using transport models, exposure studies, and identification of research needs.

- [2001 " Dosimetry Workshop" \(pdf\)](#)

This workshop was designed to coordinate dosimetry research efforts and identify research dosimetry needs. Areas discussed included particle size distributions and concentrations in supersite data; PM doses to major regions of the respiratory tract; clearance kinetics for

particle associated organics; biological targets and amplification phenomena for organics; identification of PAH and quinone fractions in PM.

- [2001 "PM Toxicity Studies: State of the Art and Future Directions"](#)  
[\(pdf\)](#)

This workshop was designed to allow coordination and interaction of researchers at each of the 5 PM Centers. Overviews of ongoing research including chronic effects of PM in children; studies in animals with preexisting airway disease; cardiopulmonary effects; acute toxicity effects; particle size and toxicology; use of concentrated air particles; dosimetry issues; and macrophage chemical components of diesel exhaust particles were discussed.

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## 1995 Air Pollutants Progress Reports

### 1995 Air Pollutants Progress Reports

#### Abstracts

Number	Identifier	Abstract	Annual/ Final Reports	Pubs Count	Proposed Start Date
1	R824791	<a href="#">Distribution of H+ and Trace Metals in Ultrafine Ambient Aerosol</a>	<a href="#">Final</a>	Total Pubs: 14 Journals: 3	October 1995 - September 1998
2	R824793	<a href="#">Development and Testing of a State-of-the-Art PMx Particulate Matter Module for Regional and Urban Air Pollution Models</a>	<a href="#">Final</a>	Total Pubs: 8 Journals: 8 -- No Books --	October 1995 - September 1998
3	R824790	<a href="#">Cellular Mechanisms of Pulmonary Inflammation by Environmental Particles</a>	<a href="#">Final</a>	Total Pubs: 9 Journals: 8	October 1995 - September 1998

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## 1996 Air Quality Progress Reports

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### Abstracts

Number	Identifier	Abstract	Annual/ Final Reports	Pubs Count	Proposed Start Date
2	R825268	<a href="#">Pulmonary Toxicity of Particulate Matter and Ozone</a>	<a href="#">Final</a>	Total Pubs: 7 Journals: 3 -- No Books --	November 1996 - November 1998
3	R825242	<a href="#">Pathophysiologic Mechanisms of Mortality Associated with Exposure to Concentrated Particulate Urban Air Toxics</a>	<a href="#">Final</a>	Total Pubs: 13	October 1996 - September 1999
4	R825275	<a href="#">Asthma Indices Associated with Ambient Submicron Particles and Formaldehyde in Ambient Air Pollution</a>	No Annual Reports	-- No Pubs --	December 1996 - November 1997
5	R825271	<a href="#">An Evaluation of Confounders in PM10/Mortality Associations</a>	<a href="#">Final</a>	Total Pubs: 7 Journals: 5	November 1996 - November 1999
6	R825247	<a href="#">Atmospheric Fate and Dry Deposition of Urban Soot to Great Waters Using a Novel, State-of-the-Art Isotopic Particulate Tracer</a>	<a href="#">1999</a> <a href="#">Final</a>	Total Pubs: 13 Journals: 5 -- No Books --	December 1996 - December 1999
10	R825264	<a href="#">Acidic PM and Daily Human Mortality in Three U.S. Cities</a>	<a href="#">Final</a>	Total Pubs: 5 Journals: 2 -- No Books --	November 1996 - November 1999
11	R825265	<a href="#">Ultrafine Particles in Urban and Respiratory Health Among Children with Respiratory Symptoms</a>	<a href="#">Final</a>	Total Pubs: 5 Journals: 3	December 1996 - December 1999
21	R825269	<a href="#">Development of a Semi-Continuous Monitor for Determination of Trace Elements and Heavy Metals in Ambient Aerosol Particles</a>	<a href="#">1999</a> <a href="#">Final</a>	Total Pubs: 6 Journals: 6	November 1996 - November 1999
27	R825253	<a href="#">Heterogeneous Chemistry of Sub-micron Aerosols Related to Tropospheric Oxidants</a>	<a href="#">Final</a>	Total Pubs: 14 Journals: 2	October 1996 - September 1999
28	R825267	<a href="#">Development of Population-Based Particle Exposure Models for Human Health Risk Assessment</a>	No Annual Reports	-- No Pubs --	December 1996 - December 1999

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### Abstracts

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1	R826232	<a href="#">Morphological and Chemical Characteristics of the Submicron Atmospheric Aerosol: Implication for Standards</a>	<a href="#">2000</a>	Total Pubs: 8 Journals: 1	January 1998 - January 2001
2	R826234	<a href="#">Real-time Measurement of the Size and Composition of Atmospheric Particulate Matter</a>	<a href="#">1999</a>	Total Pubs: 3 Journals: 2 -- No Books --	December 1997 - December 2000
5	R826233	<a href="#">The Contribution of Biomass Combustion to Ambient Fine Particle Concentrations in the United States</a>	<a href="#">1998</a> <a href="#">2000</a>	Total Pubs: 3	February 1998 - January 2001
6	R826235	<a href="#">Investigations of the Chemistry of Secondary Aerosol Formation Using Thermal Desorption Particle Beam Mass Spectrometry</a>	<a href="#">2000</a>	Total Pubs: 19 Journals: 3 -- No Books --	December 1997 - November 2000
11	R826240	<a href="#">Real-Time Monitoring of Individual Atmospheric Aerosol Particles: Establishing Correlations Between Particle Size and Chemical Speciation</a>	No Annual Reports		February 1998 - January 2001

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# 1995 Chemistry and Physics of Air Progress Reports

**Abstracts**

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Number	Identifier	Abstract	Annual/ Final Reports	Pubs Count	Proposed Start Date
1	R823979	<a href="#">Effects of Non-Uniform Cloud Drop Composition on Pollutant Transformation and Removal in Winter Clouds</a>	<a href="#">Final</a>	Total Pubs: 17 Journals: 2	October 1995 - September 1998
2	R823980	<a href="#">Speciation of Volatile and Reacting Compounds in Particulate Matter</a>	<a href="#">Final</a>	Total Pubs: 28 Journals: 12	October 1995 - September 1998
3	R823514	<a href="#">Formation and Physical Properties of Secondary Organic Aerosol</a>	<a href="#">Final</a>	Total Pubs: 6 Journals: 1 -- No Books --	September 1995 - September 1998
4	R823990	<a href="#">Organic Tracers of Plant Classes in Biomass Combustion and Smoke in Aerosols</a>	<a href="#">Final</a>	Total Pubs: 30 Journals: 14 Books: 1	October 1995 - September 1997
5	R823419	<a href="#">Lagrangian Modeling of Pollutant Dispersal in the Atmospheric Boundary Layer</a>	<a href="#">Final</a>	Total Pubs: 3 Journals: 1	October 1995 - September 1997

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## **1998 Air Pollution Chemistry and Physics Progress Reports**

### Abstracts

Number	Identifier	Abstract	Annual/ Final Reports	Pubs Count	Proposed Start Date
1	R826768	<a href="#">Modeling and Evaluation of Mechanisms Controlling the Outdoor/Indoor Relationships of Fine Particle Levels and Characteristics</a>	No Annual Reports		October 1998 - September 2000
3	R826773	<a href="#">A Modeling Investigation of NHx Cycling in the Troposphere and Its Impact on Particulate Matter and Acidic Substances Budgets</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 5 Books: 1	October 1998 - September 2001
4	R826769	<a href="#">A Portable Device for Real-Time Measurement of the Size and Composition of Atmospheric Aerosols</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 3 -- No Journals -- -- No Books --	October 1998 - September 2001
5	R826767	<a href="#">Aerosol Partitioning and Heterogeneous Chemistry</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 11 Journals: 2	October 1998 - September 2001
9	R826771	<a href="#">Partitioning of Semivolatile Organic Compounds in Organic and Inorganic Aerosols: A Unified Approach</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 7 Journals: 3	October 1998 - September 2001

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## 1999 Airborne Particulate Matter (PM) Centers Progress Reports

### Abstracts

Number	Identifier	Abstract	Annual/ Final Reports	Pubs Count	Proposed Start Date
1	R827352C001	<a href="#">Southern California Center for Airborne Particulate Matter (SCCAMP)</a>	No Annual Reports		June 1999 - May 2004
2	R827355	<a href="#">Northwest Research Center for Particulate Air Pollution and Health University of Washington</a>	No Annual Reports	-- No Pubs --	June 1999 - May 2004
3	R827351C001	<a href="#">Health Risks of PM Components</a>	No Annual Reports		June 1999 - May 2004
4	R827354C001	<a href="#">Ultrafine Particles: Characterization, Health Effects and Pathophysiological Mechanisms</a>	No Annual Reports	-- No Pubs --	June 1999 - May 2004
5	R827353C001	<a href="#">Ambient Particle Health Effects: Exposure, Susceptibility, and Mechanisms</a>	No Annual Reports		June 1999 - May 2004
6	R827353C002	<a href="#">Quantifying Exposure Error and its Effect on Epidemiological Studies</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 3 Journals: 3 -- No Books --	June 1999 - May 2004
7	R827353C009	<a href="#">Assessing Human Exposures to Particulate and Gaseous Air Pollutants</a>	No Annual Reports		June 1999 - May 2004
8	R827353C003	<a href="#">Differentiating Health Effects of Particles from Outdoor and Indoor Sources</a>	<a href="#">1999</a> <a href="#">2001</a>	Total Pubs: 1 Journals: 1 -- No Books --	June 1999 - May 2004
9	R827353C004	<a href="#">Examining Conditions in the Elderly Which Predispose Towards Acute Adverse Effects of Particulate Exposures</a>	<a href="#">2000</a>	Total Pubs: 8 Journals: 3	June 1999 - May 2004
10	R827353C005	<a href="#">Assessing Life-Shortening Associated with Exposure to Particulate Matter</a>	<a href="#">2000</a>	Total Pubs: 9 Journals: 8 -- No Books --	June 1999 - May 2004
11	R827353C006	<a href="#">Investigating Chronic Effects of Exposure to Particulate Matter</a>	<a href="#">2000</a>		June 1999 - May 2004
12	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	<a href="#">2000</a>	Total Pubs: 3 Journals: 2 -- No Books --	June 1999 - May 2004
13	R827353C010	<a href="#">Relating Changes in Blood Viscosity, Other Clotting Parameters, Heart Rate, and Heart Rate Variability to Particulate and Criteria Gas Exposures</a>	<a href="#">2000</a>		June 1999 - May 2004
14	R827355C002	<a href="#">Health Effects of PM in Susceptible Populations</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 7 Journals: 5 -- No Books --	June 1999 - May 2004
15	R827355C005	<a href="#">Mechanisms of Toxicity of PM Using Transgenic Mouse Strains</a>	<a href="#">1999</a> <a href="#">2000</a>		June 1999 - May 2004

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16	R827355C003	<a href="#">Personal PM Exposure Assessment</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 15 Journals: 1 -- No Books --	June 1999 - May 2004
17	R827355C001	<a href="#">Epidemiologic Study of Particulate Matter and Cardiopulmonary Mortality</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 7 Journals: 4	June 1999 - May 2004
18	R827355C004	<a href="#">Dosimetry Assessment: Aerosol Number, Size Distribution, and Dosimetry Measurements and Modeling</a>	<a href="#">1999</a> <a href="#">2000</a>	-- No Pubs --	June 1999 - May 2004

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# 1997 Health Effects and Exposures to Particulate Matter and Associated Air Pollutants Progress Reports

**Abstracts**

Number	Identifier	Abstract	Annual/ Final Reports	Pubs Count	Proposed Start Date
1	R826270	<a href="#">Mechanisms of Particulate-Induced Mediator Expression in Human Airway Epithelial Cells</a>	No Annual Reports		December 1997 - December 2000
2	R826246	<a href="#">Particle Toxicity and the Respiratory Bronchiole</a>	<a href="#">2000</a>	Total Pubs: 3 -- No Journals -- -- No Books --	February 1998 - January 2001
3	R826244	<a href="#">Mechanism of PM-Induced Acute Health Effects</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 9 Journals: 1	January 1998 - January 2001
4	R826245	<a href="#">The Relative Associations of Transition Metals and Sources of Fine Particulate Matter to Increased Daily Mortality</a>	<a href="#">Final</a>	Total Pubs: 6 Journals: 1 -- No Books --	January 1998 - January 2000

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# 1998 Health Effects of Particulate Matter and Associated Air Pollutants Progress Reports

## Abstracts

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Number	Identifier	Abstract	Annual/ Final Reports	Pubs Count	Proposed Start Date
1	R826779	<a href="#">Particulate Air Pollution and Initiation of Asthma</a>	No Annual Reports		October 1998 - September 2001
2	R826781	<a href="#">Human Health Effects of Exposure to Ultrafine Particles</a>	<a href="#">2000</a>	Total Pubs: 6 Journals: 4 -- No Books --	October 1998 - September 2001
3	R826784	<a href="#">Lung Injury from Inhaled Ultrafine Particles in Compromised Rats of Old Age: Influence of Priming and Adaptation</a>	<a href="#">2000</a>		September 1998 - September 2001
4	R826783	<a href="#">Relationship of Ambient Particulate Matter to Heart Rate Variability and Cardiac Arrhythmias in Elderly Adults with Coronary Artery Disease</a>	<a href="#">2000</a>	Total Pubs: 3 -- No Journals -- -- No Books --	October 1998 - September 2000
5	R826777	<a href="#">Long-Term Morbidity and Mortality Related to Exposures to Particulate Matter and Associated Air Pollutants</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 3	October 1998 - September 2001
6	R826778	<a href="#">Effect of Ammonium Bisulfate and Carbon Black Particles Inhaled Alone and in Combination on Airway Reactivity in Actively Sensitized Brown-Norway Rats</a>	<a href="#">1999</a> <a href="#">Final</a>	Total Pubs: 4 Journals: 1 -- No Books --	October 1977 - September 1999
7	R826785	<a href="#">Effects of Inhaled Ultrafine Particles on Asthma</a>	<a href="#">2000</a> <a href="#">2001</a>	Total Pubs: 2	October 1998 - September 2001
8	R826782	<a href="#">Airborne Particulate Matter-Induced Lung Inflammation</a>	No Annual Reports	-- No Pubs --	October 1998 - September 2001
9	R826780	<a href="#">Cardiovascular Vulnerability to Particulate Pollution</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 1	October 1998 - September 2001

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11	R827353C006	<a href="#">Investigating Chronic Effects of Exposure to Particulate Matter</a>	<a href="#">2000</a>		June 1999 - May 2004
12	R827353C008	<a href="#">Differentiating the Roles of Particle Size, Particle Composition, and Gaseous Co-Pollutants on Cardiac Ischemia</a>	<a href="#">2000</a>	Total Pubs: 3 Journals: 2 -- No Books --	June 1999 - May 2004
13	R827353C010	<a href="#">Relating Changes in Blood Viscosity, Other Clotting Parameters, Heart Rate, and Heart Rate Variability to Particulate and Criteria Gas Exposures</a>	<a href="#">2000</a>		June 1999 - May 2004
14	R827355C002	<a href="#">Health Effects of PM in Susceptible Populations</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 7 Journals: 5 -- No Books --	June 1999 - May 2004
15	R827355C005	<a href="#">Mechanisms of Toxicity of PM Using Transgenic Mouse Strains</a>	<a href="#">1999</a> <a href="#">2000</a>		June 1999 - May 2004

16	R827355C003	<a href="#">Personal PM Exposure Assessment</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 15 Journals: 1 -- No Books --	June 1999 - May 2004
17	R827355C001	<a href="#">Epidemiologic Study of Particulate Matter and Cardiopulmonary Mortality</a>	<a href="#">1999</a> <a href="#">2000</a>	Total Pubs: 7 Journals: 4	June 1999 - May 2004
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